America's First Aeronautical Magazine
ESTABLISHED 1916

AVIATION

JUNE 1945
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IN THIS ISSUE

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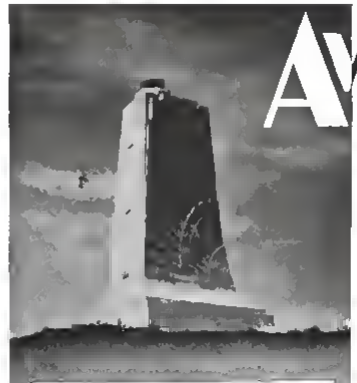

AVIATION

CONTENTS FOR JUNE, 1945

Volume 44 • Number 6

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BRIEFING

One of the most important and valuable aircraft design series it has ever been our pleasure to present begins this month as the lead feature of AVIATION's Research-Engineering-Production section. Written by Ralph Upson, one of the industry's top consultant-designers, "Designing the Personal Airplane" will, we are thoroughly convinced, do a basic, air industry job that has never been attempted before—a job we're proud to publish for the service it will render. Part I, which begins on page 119, takes up design considerations in engineering for safety, economy, and performance. Succeeding articles will cover design for speed and range; for takeoff and landing; for stability and control; and for vision; besides a discussion on amphibious and roadable craft and a look into the future of design requirements.

Immediately following is the most complete article yet to be offered on the Aeronautical Products, Inc., helicopter, giving heretofore unpublished design and construction details on this flying laboratory. It's written by AVIATION's Detroit Editor Chet Ricker, who illustrated it with his own outstanding on-the-spot sketches. Page 122

Ask most any two people how far, how fast, and where jet propulsion is going—and the chances are you'll get ten answers. As an integral part of a huge program to design, develop, and produce the first all-American gas turbine jet engine for the U. S. Navy, Westinghouse engineers made a thorough study comparing conventional reciprocating engines, straight gas turbine jets, and turbine-driven propellers, to show just what fields could be served most efficiently. Results of this study, written by Charles D. Flagle and Frank W. Godsey, design engineer of the Aviation Gas Turbine Div. and Manager, New Products Div., respectively, are presented on page 131

Up in Boston. Wiggins Airways had a tough problem: How to sell flight courses to—and make plane prospects of—several different classes of prospects and do it in a single campaign. A carefully-developed set of selling "packages" did the trick, and did it well. What's in the various packages and how their contents work are found under Marketing, page 114

Of equal interest and value to the fixed base operators is our Civil Operations feature, "Why's and How's of Good Airport Turfing," a practical, down-to-earth (and no pun intended) article which will help down the dust bogey and make airports more efficient and attractive. You'll find it on page 167.

And speaking of efficiency, "Al" Lindsley this month shows (page 157) how the modern maintenance organization can be set up and operated to give the customers the best possible service and at the same time make the the most possible money for the operator.

Data on two extremes in new aircraft are presented this month. First, on page 163, there's specifications on the single-place 50-hp. low-wing craft designed for easy maintenance by Aviation Boosters, Inc., of Kansas City. And on page 164 we present all available information on Britain's new Blackburn design for a six-engine 155-ton flying boat aimed at top capacity of 160 passengers and cargo in a pressurized cabin.

And don't overlook Part III of Jim Ray's series on feederline fundamentals. This month (page 110) he outlines procedures for establishing both direct and indirect costs, and for measuring them against potential income, to get the right answer to the perennial $64 question: Will it pay?

AVIATION'S WASHINGTON EDITOR Blaine Stubblefield (who has a swell sense of humor despite this serious demeanor) is seen here aboard the U.S.S. Bonhomme Richard, one of the Navy's newest and most formidable aircraft carriers. Stubb embarked, as the ship headed for a vital role in the Pacific, to get a first-hand story on how maintenance is carried out on a floating airport. His story, a tribute to the young men who perform under really rugged conditions, begins on page 106. (Official U.S. Navy photo)

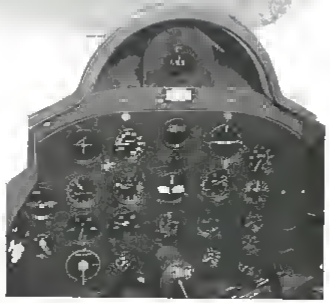
From the down-under land we present an on-the-spot report covering Australia's postwar manufacturing and transport plans. Involved are more than one American plane type. See page 109

Down the Years in AVIATION'S LOG

25 Yr. Ago (1920)—Airplane exhaust cabin heating first installed by British. . . Martin builds twin-engine Navy torpedo plane with folding wings. . . Italians complete Roma, semi-rigid airship with 19-ton load capacity. Army builds groundstrafer plane with 37 mm. cannon and bomb racks.

15 Yr. Ago (1930)—Pilot Mermoz, of Compagnie Aeropostale, makes first commercial nonstop flight between France and U. S. . . Air Ferries, Ltd., of San Francisco, carries up to 11,000 passengers monthly. . . . Capt. Page wins Curtiss Marine Trophy at 164 mph. . . Senate requires publication of all Dept. of Commerce accident reports. . . Martin has contract for 55 patrol flying boats at $44,500 each. . . D. of C. officials fly gliders to obtain first-hand data for regulations. . . Besler and Doble test steam-powered Curtiss Robin at Alameda. . . Navy orders 27 light carrier-based bombers from Boeing for $400,000.

10 Yr. Ago (1935)—Douglas planes now used on airlines of nine foreign countries. . . DC-1 breaks eight records for transport planes in ranges up to 3,100 mi. . . Bureau of Air Commerce starts survey of twelve blind-landing transmitter sites. . . . *Maxim Gorky*, 8-engine Soviet plane wrecked in accident. . . Senate passes $460,000,000 Naval Appropriations Bill giving aviation $40,997,000 for new planes. . . Navy stages large scale maneuvers in Pacific, using three aircraft carriers. . . Yves Lacombe sets new mark of 290 mph. over 100 km. (62 mi.). . . Amelia Earhart flies non-stop from Mexico City to Newark. . . Panam lists total assets at $24,000,000 and gross income at over $9,600,000. . . Douglas makes first official announcement of DC-3. . . Airlines expect 32,000,000 passenger-miles per month. . . Kellett wingless autogiro publicly demonstrated. . . Indiana holds annual air tour. . . Russians launch semi-rigid airship.



Instrument Panel of the new '45 Link Trainer

Simulating — in many *flight-like* ways than ever before — the problems of flight and navigation, the new Link Trainer is another step forward in teaching instrument flying technique and developing the pilot's individual skill. As on previous models, many Kollsman Instruments are used.

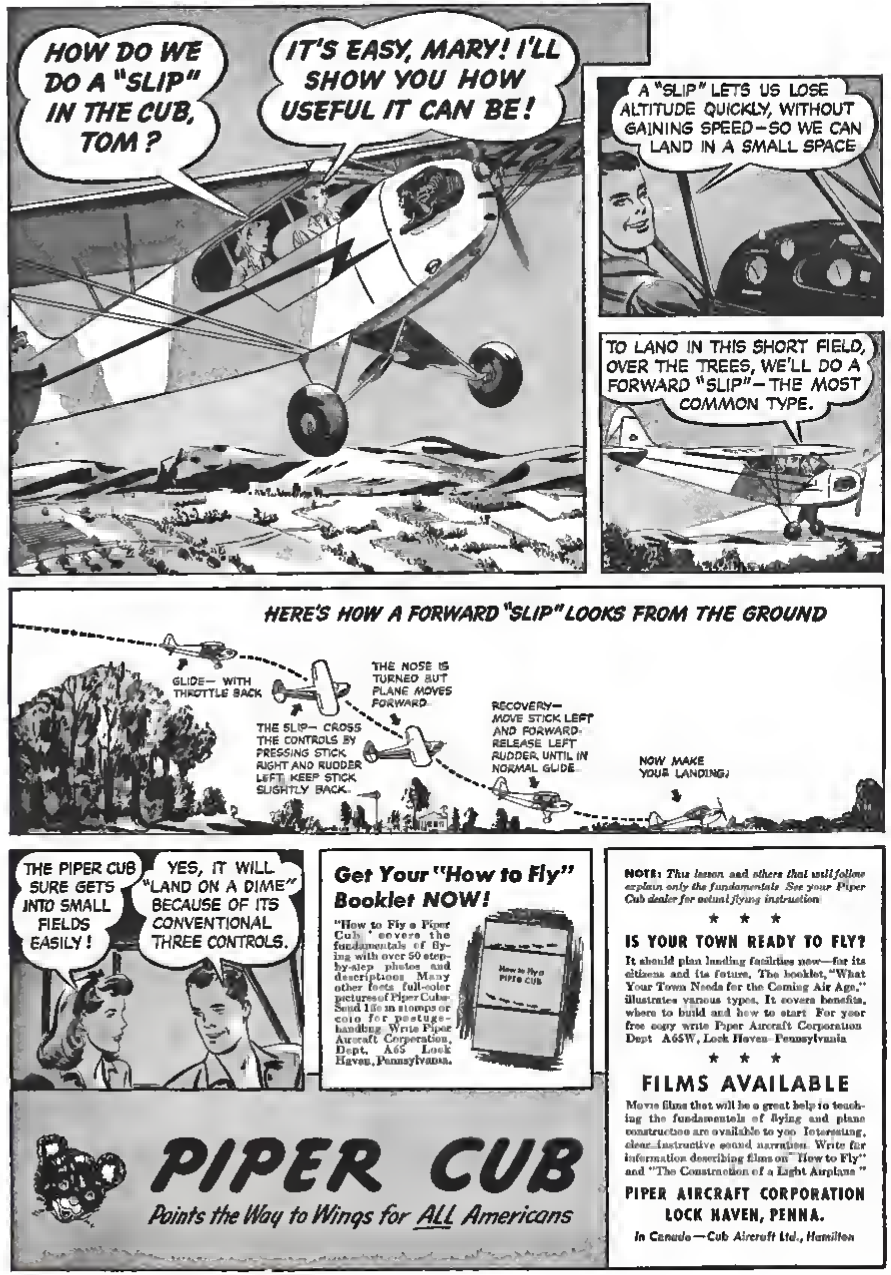
THE LINK TRAINER has played an indispensable part in the excellent operations and safety record of the nation's airlines and Air Forces. It has been steadily improved until, in the latest model, its flight-like instrumentation and controlling devices dramatically duplicate practically every cockpit operation necessary in the piloting of a plane. The Kollsman flight, navigation and engine instruments used in the Link Trainer are especially designed for the purpose, simulating in every respect the action of such instruments in actual flight. Other Kollsman devices, such as synchronous remote control motors, provide the instant indication and control required between the cockpit and the instructor's desk. Dependability and accuracy of these instruments and devices as they appear in the Link Trainer are of the same high standard which has won for Kollsman the respect of all aviation.

KOLLSMAN AIRCRAFT INSTRUMENTS

PRODUCT OF

SQUARE D COMPANY

ELMHURST, NEW YORK GLENDALE, CALIFORNIA



GOODYEAR AIRCRAFT PRODUCTION REPORT

CONTRACTS: NOAS846 NOAS2676

GRUMMAN F6F (Hellcat)

WINGS, ELEVATORS, AILERONS, INNER AND OUTER FLAPS

CONTRACT RECEIVED: *AUGUST 1943*

FIRST PRODUCTION UNIT DELIVERED: *OCTOBER 1943*

1700TH PRODUCTION UNIT DELIVERED: *DECEMBER 1944*

REMARKS. Started from the original blueprints, these major components of the Ace Grumman fighter plane required all the "extras" of production engineering, tooling and personnel training of Goodyear Aircraft. Complex problems had to be overcome—in job analysis and detail breakdown, as well as in speedy tool designing. Battle-prescribed modifications were effected while full production was maintained through utilization of the fased "quick-fix" system. Proof of all this was the fact that the first pair of wings was assembled and delivered only two months after receipt of the go-ahead, and the 1,700th only fourteen months later. Another milestone in Goodyear's contributions to the United States Navy.

Goodyear is building components for 16 different Army-Navy types of aircraft, including complete Corsair fighters and airships.

HOW GOODYEAR AIRCRAFT CORPORATION SERVES THE AIRCRAFT INDUSTRY

1. By constructing major components to manufacturers' specifications.
2. By designing parts for all types of airplanes.
3. By re-engineering parts for quantity production.
4. By building complete airplanes and airships.
5. By extending facilities of Goodyear Research Laboratories to aid the solution of any design or engineering problem.

GOODYEAR AIRCRAFT

GOODYEAR AIRCRAFT CORPORATION
Akron, Ohio • Litchfield Park, Arizona


GOODYEAR
THE WHEEL IS A GOODYEAR, TOO.
To mount the world's largest airplane tire, Goodyear builds this magnesium-alloy wheel. Unit will be equipped with the time-proved Goodyear Multiple Disc Brake.
ALL OUT FOR THE MIGHTY 7th— BUY MORE WAR BONDS!
THE BIGGEST TIRE THAT FLIES
LOOKING forward to the day of air leviathans far larger than anything now in the skies, Goodyear is ready with the largest airplane tire ever built —with tubes, wheels and brakes to match.
These new giants are 110 inches in over-all diameter and 46 inches wide. They are bodied with 34 plies of superstrong nylon fabric—enough nylon to make approximately 12,000 pairs of women's hosiery. They weigh 1,500 pounds each, and when inflated contain 150 cubic feet of air, at a pressure of 100 pounds per square inch.
That this new mammoth is able to carry safely, loads far beyond the maximum weight of present-day aircraft has been proved by tests in governmental as well as in Goodyear's aeronautical laboratories.
In these new tires you see another example of how Goodyear keeps pace with the most advanced thinking of the aviation industry, developing and proving new products to be ready for new aircraft designs. Our engineers will be happy to consult with you in developing new applications of any of the Goodyear aviation products listed below.
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AVIATION PRODUCTS
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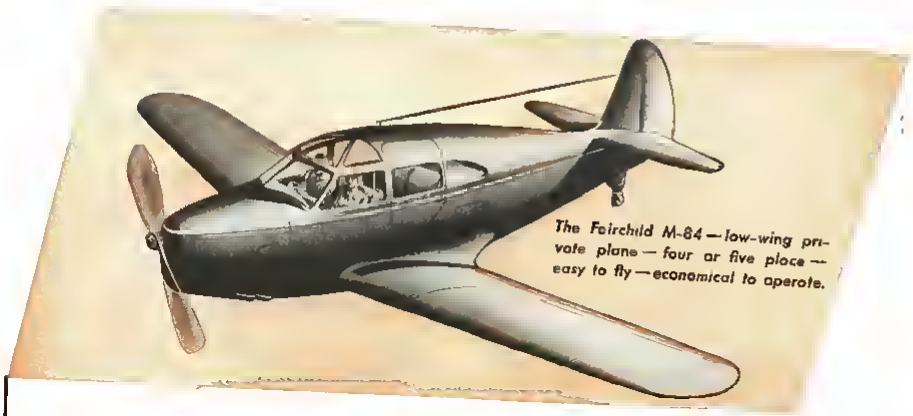


The Fairchild M-84 — low-wing private plane — four or five place — easy to fly — economical to operate.

LOOKING AHEAD WITH LEAR

Fairchild believes comfort, safety and economy will be the saught-for factors in the postwar private plane.

So, profiting by the wealth of knowledge gained from the famous Fairchild PT-19 training plane used by thousands of Air Force Cadets, they have developed plans for this M-84.

Fairchild knows from way back what Lear Radios can do and has included provisions for Lear equipment in the M-84.

Lear has been making fine radio and direction-finding equipment since 1930. It is being used in private planes, commercial transports and government ships with utmost dependability. It is noted far its unusual light weight and keen sensitivity.

LEAR, Incorporated — Radio Division: Grand Rapids 2, Michigan • Aircraft Radio Sales: 1860 Broadway, New York 23, New York • West Coast Subsidiary: Lear, Inc. of Calif., 1010 N. Highland Ave., Los Angeles 38, Calif.

Lear INCORPORATED

Formerly Lear Avia, Inc.

Fairchild says this about Lear

"We at Fairchild have always found that owners of private airplanes who use Lear equipment are unanimously enthusiastic about its performance, and the installation of Lear equipment in our airplanes is ideal from the space and weight standpoint."

Fairchild Aircraft
James A. Wales Jr.
Asst to General Manager

LEARADIO the pilots' preference

Always Nearer to Nippon

FLOAT Planes, Kingfisher OS2Us, act as the "eyes" of our fleets, scouting the waters ahead as we close in on the Japs.

They seek out targets beyond the horizon . . . and spot for the battleships' big rifles.

They search the seas for our overdue planes and crews and have run up a record for rescues that has earned them imperishable fame as "the mercy ships of the air".

It is the ability of the OS2U to take it—in punishing choppy-water landings, in rough weather action under service conditions, that has made this rugged little ship so indispensable for so long.

Edo Floats are standard equipment on Navy seaplanes.

OS2Us are shot from the decks of our cruisers by an explosive charge that accelerates them to "flying-speed" in the length of the catapult track. On return they land in the water to be picked up alongside by a hoist and lifted back onto the catapult carriage ready for the next mission

EDO FLOAT GEAR

SERVES THE UNITED NATIONS

EDO AIRCRAFT CORPORATION, 402 SECOND STREET, COLLEGE POINT, L. I., N. Y.

★ Dependable

More than 35,000 Janitrol Aircraft Heaters have been produced for military airplanes. Proof of their unmatched reliability is the fact that an increasingly larger proportion of Allied plane installations are Janitrols.

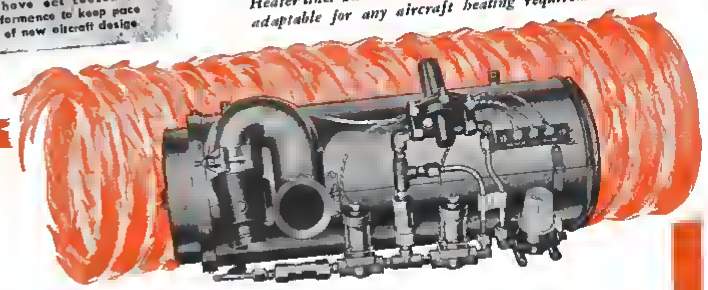
★ Long Life

Performance records reveal long, trouble-free and continuous service. Designed for 1000 hours operation, many Janitrol Aircraft Heaters have operated for upwards of 4000 hours and are still delivering highly satisfactory service.

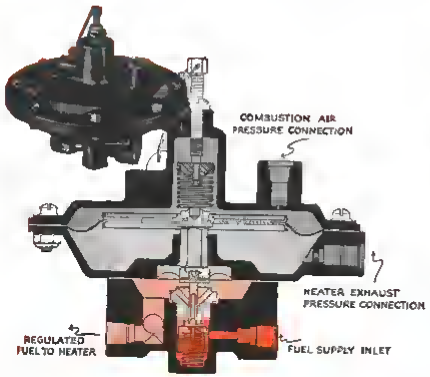
★ Efficient

Heart of every Janitrol Aircraft Heater is the amazing "Whirling Flame" that has established new standards for heating efficiency. Even so, Surface Combustion engineers have not ceased to further improve heater performance to keep pace with the constant progress of new aircraft design.

A wide variety of models and sizes ranging from 15,000 Btu's to units with 185,000 maximum Btu per hour output capacity, comprise the Janitrol Aircraft Heater line. There's a unit ideally suited or readily adaptable for any aircraft heating requirement.



The "Whirling Flame" that's flying higher and farther . . .



Improved Air Loaded Fuel Pressure Regulator

This new simplified design of control is typical of the continuous development work carried on by Surface Combustion engineers to further improve the remarkable performance of Janitrol Aircraft Heaters.

The control is compact and lightweight, it assures clean, efficient combustion over a wide range of speeds and altitudes.

By automatically maintaining a constant fuel and air ratio for a specified altitude, heaters light and burn efficiently regardless of the flying conditions.

Because this control need not be attached to the heater, one Fuel Flow Regulator can be used to control a series of heaters, where this is desirable.

As America's planes reach new altitudes—fly faster and greater distances—the *"Whirling Flame"* flies with them. For we at Surface Combustion are constantly developing aircraft heaters to *keep pace* with the never ending progress of the aviation industry.

In our laboratories, through experimental field tests and many thousands of actual installations, continued study and research is resulting in heaters that not only meet the needs of today but also anticipate many of the requirements of tomorrow.

So whatever your plans in aircraft design or operation, now or in the future, look to Surface Combustion for *constant development* in aircraft heating.

Note to Postwar Product Designers

Planning busses, trucks, boats or trains in which effective mobile heat is required? Perhaps our unique experience with the *"Whirling Flame"* principle can help you with your problem. Write Surface Combustion for further information.

Janitrol

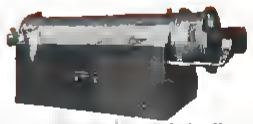
SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

America's oldest and largest manufacturer of gas-fired industrial and domestic heating equipment, with more than 30 years' experience in combustion research, and in the application, control and transfer of heat

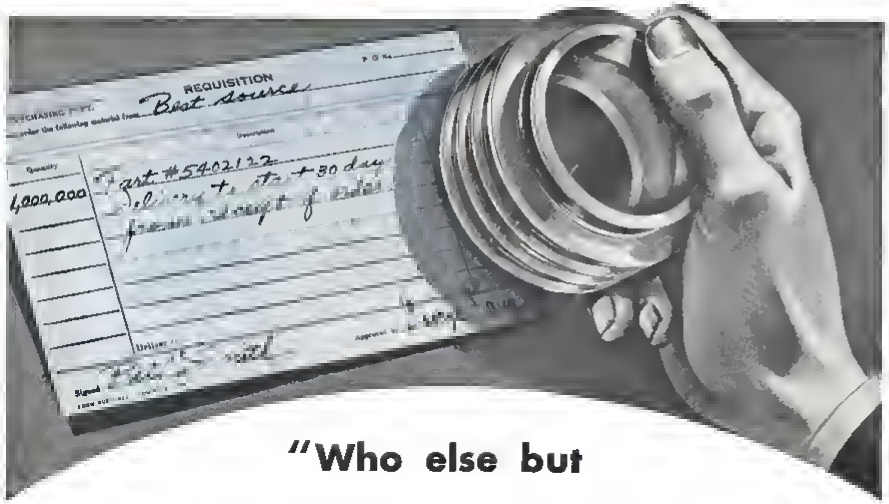
PORTABLE GROUND HEATER

This portable, self-contained ground heater furnishes reliable heat for engines, hangars, work shops, to dry out condensation, and for many other purposes. Will start and operate at temperatures as low as 40° below zero.

PORTABLE AIRCRAFT HEATER



Newest addition to the Janitrol line is a completely self-contained portable heater, including its own fuel tank and pump for use up to 15,000 feet altitude. Because it is designed to operate with air taken from the inside of the plane, it is not necessary to engineer and build in extensive air scoops. Simply connect the heater to an electrical outlet, and you have immediate heat — even though the plane wasn't designed, no provision made, for a heating system.



"Who else but *Aeronautical Products* could turn out a part like this, in volume?"

LET today's planning be that Peace will come tomorrow! Overnight you must be ready to stop working for the few and begin to meet the demands of the many. What will you have to sell? New products . . . new designs for old . . . test models on which to form your production pattern . . . new parts for mass civilian production? Then, *it's a job for Aeronautical Products!*

API is the story of a vigorous American enterprise that became a production giant . . . proof that engineering brains, skilled workmen and precision machinery can work wonders. » » » » Two great plants tooled to perfection . . . poised and ready to serve you *completely*. Write our Executive Sales Office for plant equipment facilities . . . be ready *when the day comes!*

BUY WAR BONDS

* *Make ownership of a safe, sturdy Aeronautical Products Helicopter a "must" in your personal postwar plan. You'll find you can afford one!*

AERONAUTICAL PRODUCTS, Inc.

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FRICTION SAWING easy with DoALL Zephyr

Here it is—Friction Sawing, the modern way to cut hard ferrous metals—to step up production as much as 7-fold.

The saw cuts with an action similar to that of "torch cutting" but there are no twisted, distorted shapes of thin materials—no jagged edges; in fact, on many jobs the finish is so smooth that further machining is unnecessary

The Zephyr is safe. Equipped with automatic safety brake for instant work stoppage and the blade is fully enclosed in strong steel housing, except at work table

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Best Way to Cut
STAINLESS STEEL
ALLOYS · TUBING
ARMOR PLATE
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Send for copy of the new booklet FRICTION SAWING and other Zephyr performances.

DoALL

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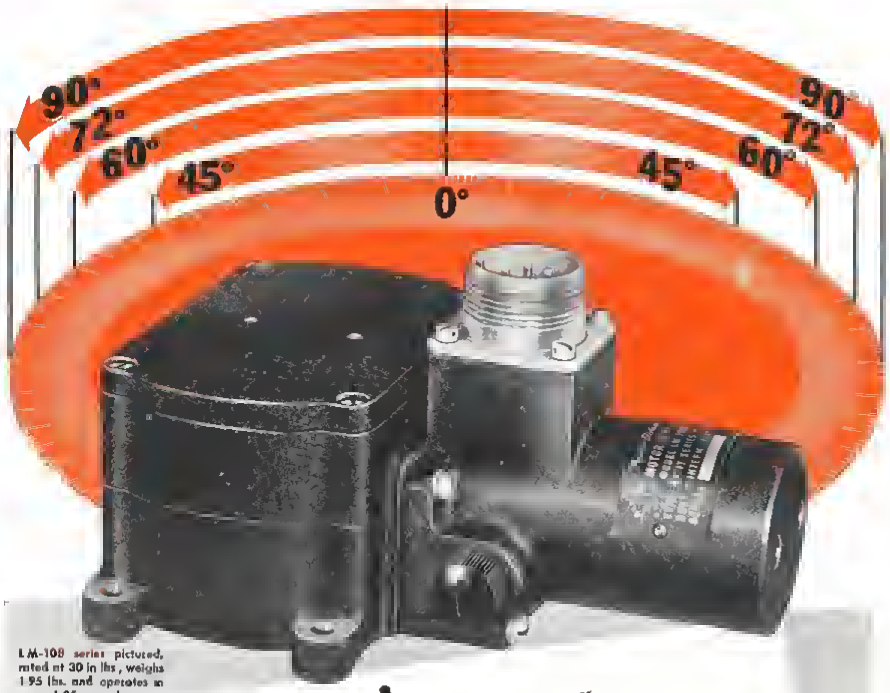

LM-108 series pictured, rated at 30 in lbs, weighs 1.95 lbs. and operates in 1.25 seconds.

POSITIVE MECHANICAL POSITIONING WITH THESE REVOLUTIONARY

GENEVA-LOC ACTUATORS

Revolutionary Geneva-Loc Actuators* — for the first time incorporating a positive positioning geneva movement — give mechanically controlled travel with new trouble-free simplicity. Introduced only six months ago, Geneva-Loc Actuators are being specified and used for a great range of applications.

Operated by a high speed electric motor, these new actuators provide from two to eight positions, each positively locked against movement and completely independent of motor overtravel. Clutches, brakes and adjustable limit switches have been eliminated. Standard units are available with travel increments of 45°, 60°, 72° or 90°.

The Geneva-Loc motor starts at no load and is turned off, after completion of the operation, at no load, a condition ideal for long motor and switch life. The gear ratio is constantly variable, starting at infinity and ending at infinity, resulting in smooth starts and stops and giving greatly extended gear life.

Geneva-Loc Actuators are not intended for modulating applications but can be used to advantage on any installation where positions are predetermined and if more than two, equally spaced. Pacific Division Engineers are available to confer with you on your particular problem. Write or wire for Bulletin BA-102 containing complete data.

Pacific Division, Bendix Aviation Corporation, 11620 Sherman Way, North Hollywood, California. Lincoln Building, New York 17. Continental Building, St. Louis 8.

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Pacific Division
BENDIX AVIATION CORPORATION

HERE'S THE ANSWER TO THE QUESTION:

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Aircraft TOOLS, INCORPORATED
LOS ANGELES 1, CALIFORNIA
DALLAS 8, TEXAS DETROIT 2, MICHIGAN

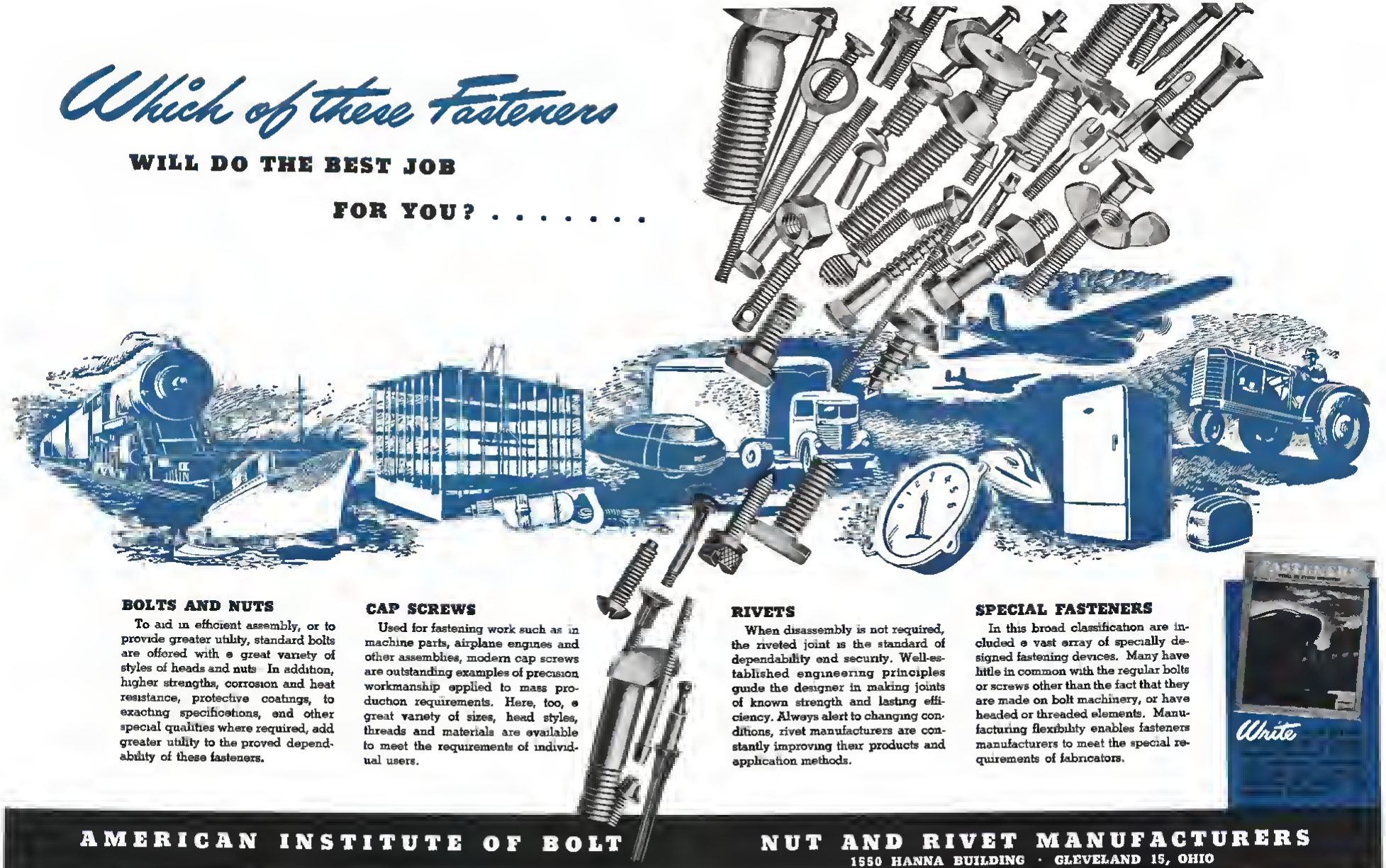
New Catalog Available to Industry Personnel.

Complete Repair Service for All Types of Aircraft TOOLS.

Which of these Fasteners

WILL DO THE BEST JOB

FOR YOU? . . . . . .



BOLTS AND NUTS

To aid in efficient assembly, or to provide greater utility, standard bolts are offered with a great variety of styles of heads and nuts. In addition, higher strengths, corrosion and heat resistance, protective coatings, to exacting specifications, and other special qualities where required, add greater utility to the proved dependability of these fasteners.

CAP SCREWS

Used for fastening work such as in machine parts, airplane engines and other assemblies, modern cap screws are outstanding examples of precision workmanship applied to mass production requirements. Here, too, a great variety of sizes, head styles, threads and materials are available to meet the requirements of individual users.

RIVETS

When disassembly is not required, the riveted joint is the standard of dependability and security. Well-established engineering principles guide the designer in making joints of known strength and lasting efficiency. Always alert to changing conditions, rivet manufacturers are constantly improving their products and application methods.

SPECIAL FASTENERS

In this broad classification are included a vast array of specially designed fastening devices. Many have little in common with the regular bolts or screws other than the fact that they are made on bolt machinery, or have headed or threaded elements. Manufacturing flexibility enables fasteners manufacturers to meet the special requirements of fabricators.

AMERICAN INSTITUTE OF BOLT NUT AND RIVET MANUFACTURERS

1550 HANNA BUILDING · CLEVELAND 15, OHIO

EXIDES—WITH AMERICA'S ARMADAS OF THE AIR

From scores of flat tops, the Navy planes take off, one mission following another with steadily mounting success. America's armadas of the air constitute one of our most potent weapons of offense.

On thousands of these planes—and on other thousands of land-based aircraft—powerful, rugged Exides are providing current for all electrical needs. Tomorrow, Exide Batteries will be serving other air armadas—those vast new fleets of commercial and private planes that soon will be riding the airways around the world.

And, as they have been doing since 1917, Exides will be serving with dependability, long-life and ease of maintenance.

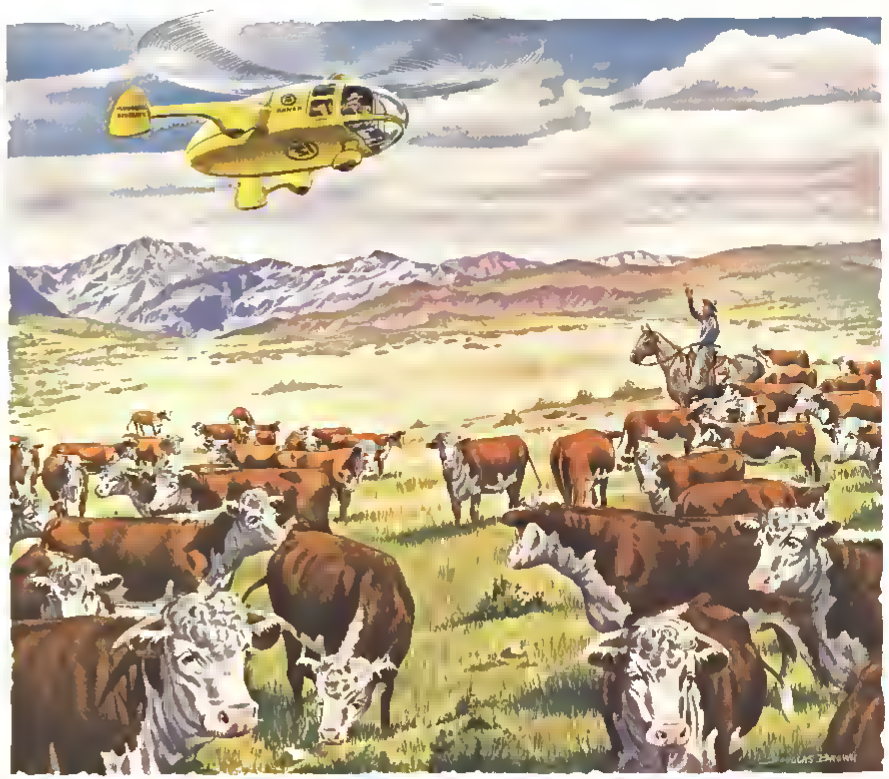
A LETTER FROM FAR-OFF INDIA

Letters are regularly received from many of the more than 1400 Exide employees in the service. This one comes from half way around the earth:

"The Exide battery is doing a good job on our ships. It's a honey and holds up quite a load. When I fly with the battery I visualize all you people behind me. Exide is really a pass-word over here."

Exide AIRCRAFT BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32 • Exide Batteries of Canada, Limited, Toronto



Ridin' Herd by Helicopter

Many of America's larger Western cattle ranches cover thousands of acres . . . with good grazing land separated by stretches of rough, rocky, and terrain. Into such areas, calves and cattle frequently stray and are lost, representing a total loss in annual beef production of many thousands of pounds.

The use of the *helicopter*, postwar, for patrol purposes, could locate and save thousands of strays. For the helicopter is capable, almost literally, of "ridin' herd." Not only can it cover vast distances daily, to report the location of strays by direct radio telephone communication, but it can also descend into narrow valleys and canyons, to pick up lost calves, and where necessary, even full-grown cattle.

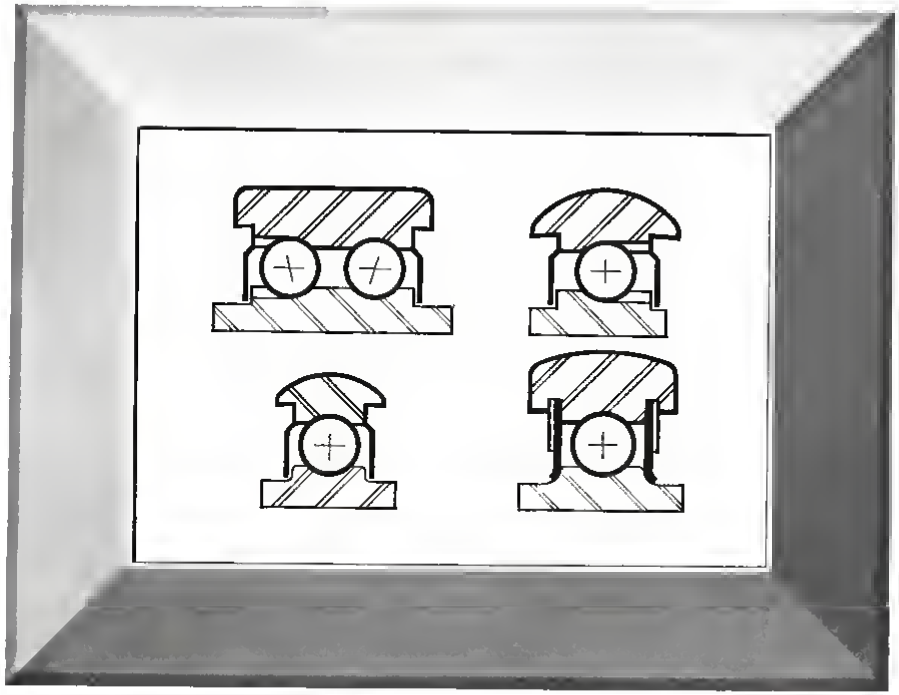
In addition, it can be invaluable when used for frequent checkups on all-important water facilities, carrying supplies to mend windmills, pipes, etc. Fence patrol and mending too, are vital functions for which the helicopter is ideally suited.

Operated by professional pilots, the helicopter can save ranch owners thousands of dollars and many thousands of pounds of beef, *postwar*. For it is swift, safe, and almost unmatchably low in cost of operation per *ton-mile* to inaccessible areas.

At McDonnell, *right now*, our biggest job is to turn out more planes, parts, and plastics for war . . . a job we're working at night and day. But after victory . . . we are looking forward to showing you how the helicopter can serve your own specialized commercial transportation needs . . . for almost any type of use . . . almost anywhere in the world.

McDONNELL *Aircraft Corporation*

Manufacturers of PLANES • PARTS • PLASTICS ★ SAINT LOUIS-MEMPHIS ★



PORTRAIT *of a Joint Achievement*

Fafnir and aircraft engineers design ball bearings that function as wheels on tracks for canopy, pilot's seat, gun mounts and in the new telescoping flaps.

Putting a ball bearing in a wheel . . . that's not spectacular. But take away the wheel and make the ball bearing do the whole job of a heavy-duty track roller . . . and you've got a real problem.

Obviously the answer is to strengthen the outer ring so that it can take the load and to carefully curve the outer surface so that it will not gouge the roller tracks. But just how much thickening of the section and what kind of curvature?

When you look at these cross-section views, the answer looks simple. But it took long research to find the type of curvature and the amount of thickening of the outer ring which would provide maximum load capacity with minimum weight. Out of these joint studies and experiments, Fafnir developed a complete line of track roller bearings for friction-free rolling of these plane parts.

They are deep-groove ball bearings, made of ball-bearing steel, through-hardened for greatest strength, pre-lubricated and shielded . . . latest designs include the new Fafnir Plya-Seal.

This line of Fafnir Track Roller Ball Bearings is one more addition to the growing list of aircraft-specialized ball bearings . . . and another example of leadership in aircraft bearing design and production. Data sheets on these Track Roller Type bearings are available upon request. The Fafnir Bearing Company, New Britain, Connecticut

★ 2182

FAFNIR

BALL BEARINGS

Most Complete Line in America

THINK IN TERMS OF MAGNESIUM

consider this extruded shape, for example

• This hollow extruded magnesium shape was designed by American Magnesium to give the textile mills a better cloth roll. It has a degree of permanence never before attained. Light in weight, these rolls make handling easier, simplifying a labor problem. Strong and stiff, they're able to stand up under heavy loadings. There's no distortion, no cracking, no splintering.

Doesn't this shape suggest some interesting possibilities to you?

The extrusion process helps you employ metal to best advantage. Magnesium lets you save weight most efficiently. We'll gladly work with you in adapting both advantages to your products. Aluminum Company of America, Sales Agent for American Magnesium products, 1713 Gulf Building, Pittsburgh 19, Pennsylvania.

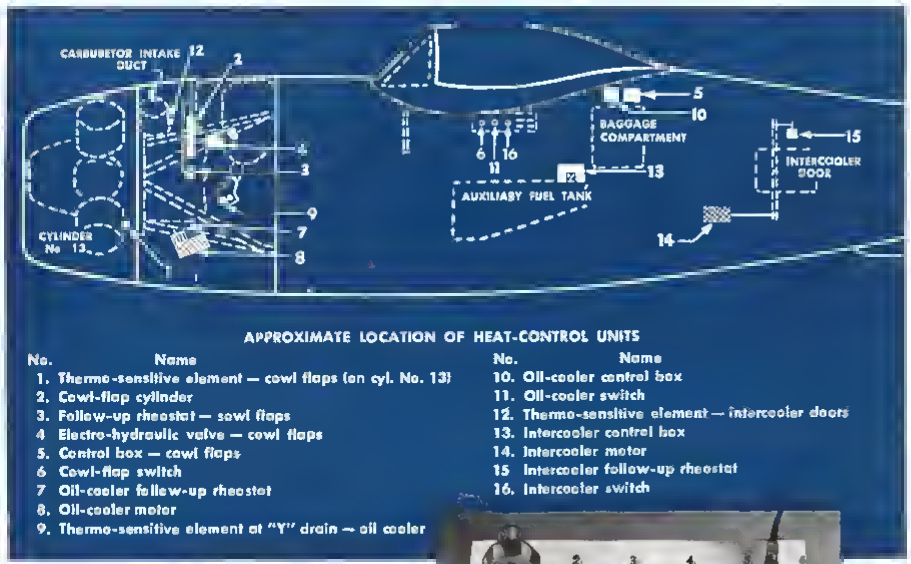
MAGNESIUM MAZLO PRODUCTS

AMERICAN MAGNESIUM CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

G-E AUTOMATIC TEMPERATURE CONTROL PUTS AN END TO EXCESSIVE FLAP DRAG

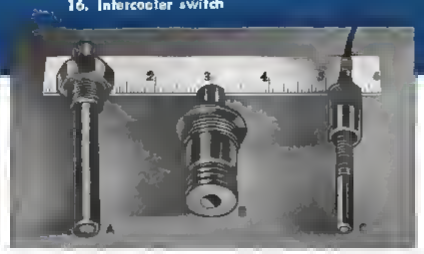
Only 4.6 lbs added... up to 40 mph regained



APPROXIMATE LOCATION OF HEAT-CONTROL UNITS

No.	Name	No.	Name
1.	Thermo-sensitive element — cowl flaps (on cyl. No. 13)	10.	Oil-cooler control box
2.	Cowl-flap cylinder	11.	Oil-cooler switch
3.	Follow-up rheostat — cowl flaps	12.	Thermo-sensitive element — intercooler doors
4	Electro-hydraulic valve — cowl flaps	13.	Intercooler control box
5.	Control box — cowl flaps	14.	Intercooler motor
6	Cowl-flap switch	15	Intercooler follow-up rheostat
7	Oil-cooler follow-up rheostat	16.	Intercooler switch
8.	Oil-cooler motor		
9.	Thermo-sensitive element at "Y" drain — oil cooler		

Diagram shows the location of components in a typical application of G-E temperature control. Controllers (the only heavy components) can be located almost anywhere in the ship. All components except thermal elements are interchangeable. The system operates on 24 volts d-c.



The thermo-sensitive elements include: A, used for oil or engine coolant; B, for carburetor air; C, for engine head. The small size of these elements facilitates their location where space is at a premium.

PILOTS FREE TO CONCENTRATE ON FLYING

COMBAT pilots shouldn't have to be continually adjusting the position of cooling flaps and exit shutters. Yet, in the past, that was the only way they could minimize drag consistent with engine cooling requirements. The tendency was to play it safe, leaving flaps and shutters open wider than necessary. The resulting drag caused as much as 10 per cent loss of speed on a 400-mph ship.

It's a different story now, because of G-E automatic temperature control!

Employing a remarkable new temperature-sensitive material, General Electric has developed a system that *automatically* positions flaps to maintain the most efficient temperature of engines, oil, carburetor air, and coolant. Excessive drag is avoided. So is the danger of overheating. The pilot can devote *all* his attention to other duties.

LIGHT WEIGHT

This new G-E system involves but a slight weight penalty: only 4.6 pounds in the case of engine-head temperature control. It holds temperature accurately, without hunting. It is flexible, being adaptable to almost any type of temperature control, and is easily applied because all components are interconnected electrically.

G-E automatic temperature control is used on important planes now in production, and will be installed on several other new fighter, bomber, and cargo ships. It should be a "natural" for postwar commercial planes from the standpoints of both fuel economy and freedom for pilots.

May we tell you why automatic temperature control and other G-E pre-engineered systems for aircraft can mean substantial savings in engineering man-hours and assembly time for you? *General Electric Company, Schenectady 5, N. Y.*

The heart of the new system is this G-E developed controller. A highly sensitive, polarized relay (in top of case) responds to the signals from the thermo-sensitive elements, energizing power relays (below). The power relays then actuate the flap motor to open or close the flaps. The rate of response is extremely rapid, and the follow-up principle employed insures positive operation without hunting.

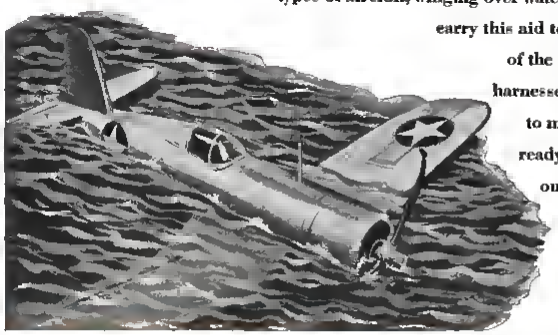
Buy all the BONDS you can —and keep all you buy

PRECISION PRODUCTS & ENGINEERED SYSTEMS FOR AIRCRAFT

GENERAL ELECTRIC

WHEN DOES A PLANE NEED A LIFE PRESERVER?

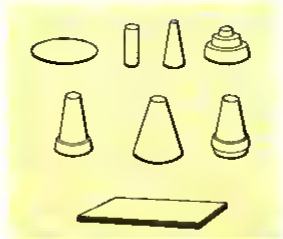
Before the war, when carrier-based planes made a forced landing at sea, they floated safely on giant water-wings. ¶ The instant the plane struck the water, Kidde Flotation Gear went into action *automatically*. Carbon dioxide—stored under high pressure—was released by the action of a water-sensitive mechanism . . . inflating rubberized bags stored in wing compartments. Ont popped the bags—to keep plane and crew afloat till rescue arrived! ¶ During the war, Kidde Flotation Gear has given place to armor and armament; its weight has been sacrificed in the interests of speed and maneuverability. The *crew* is saved by Kidde-inflated rafts, but the plane itself is expendable. ¶ But when the war is over, Kidde Flotation Gear will find a host of new applications. Many types of aircraft, winging over water on long-distance flights, will probably carry this aid to safety. ¶ Flotation Gear is one of the many devices in which Kidde skill has harnessed the energy of gases-under-pressure to make flying safer. Kidde engineers are ready to work with *you*—just drop a line to our Product Development Department.



The word "Kidde" and the Kidde seal are trade-marks of Walter Kidde & Company, Inc.

Walter Kidde & Company, Inc. • 140 Cedar Street • New York 6, N. Y.

*MORAINE POROUS METAL



MPM elements for filtration, separation, diffusion, flow control, flame arresters

Whether the application is a household refrigerator or an Army tank, a fighter plane or a civilian automobile—*precision parts* are the heart of performance.

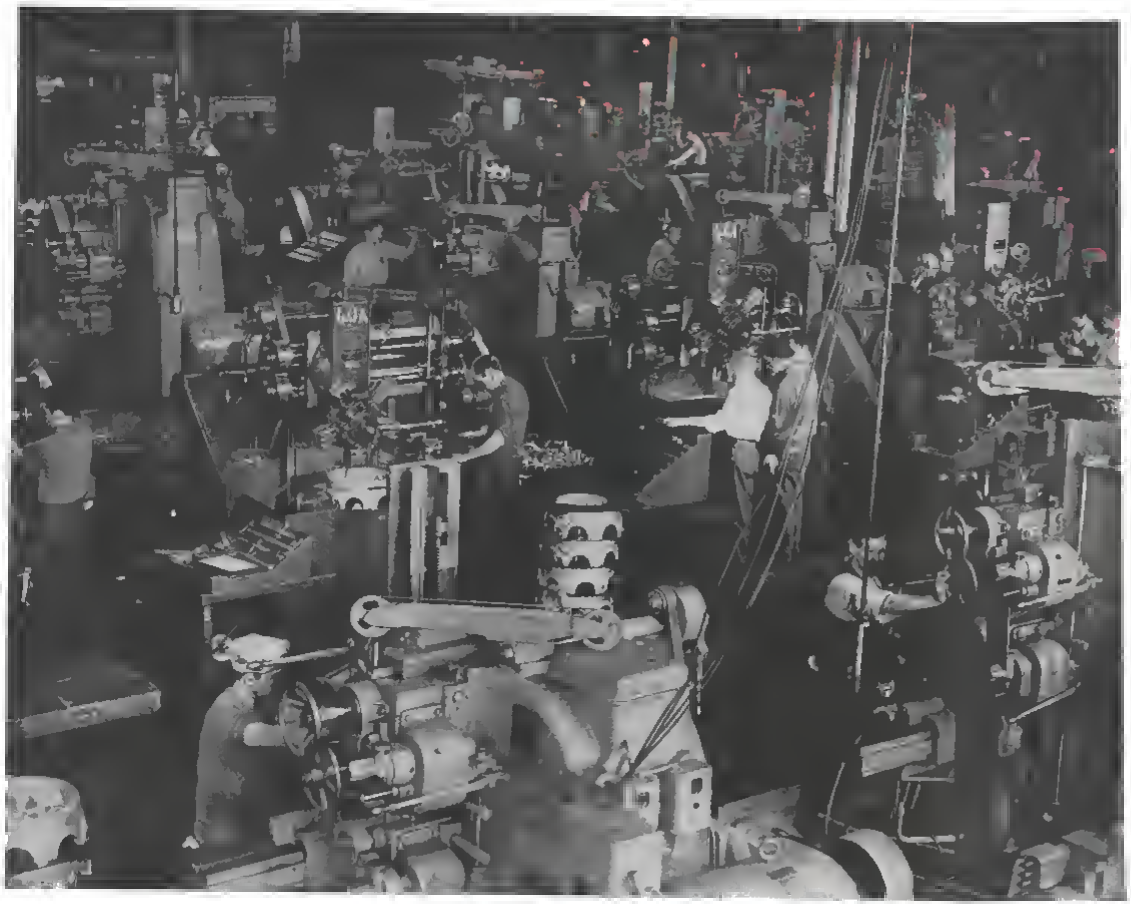
But *attaining* precision is only half the story. The other half is *maintaining* it under operating conditions—and here Moraine Porous Metal filter elements have a lot to offer American industry. Designed into the application, this unique product of powder metallurgy uniformly filters out harmful particles down to .0005 inch—provides a tortuous flow passage that traps, impinges and stops dirt—safeguards close-fitting parts, polished surfaces and fine orifices against abrasion and clogging.

If your products or processes involve a flowing medium that has contact with precision parts, you should investigate Moraine Porous Metal. Our engineers will work with you to determine the most efficient grade, size, shape.

WAR BONDS SAVE LIVES

MORAINE PRODUCTS DIVISION OF **GENERAL MOTORS**
DAYTON, OHIO

RUST PROOFING



GOVERNMENT-OWNED PRODUCTION EQUIPMENT

SEE Ordnance Specificotion P.S. 300-4 for official instructions

USE Texaco Rustpraofing Praducts

RECONVERSION time—when it comes to your plant—will call for prompt storage of Government-owned machines, precision tools and other production equipment. Before this equipment can be stored it must be rustproofed and processed *in accordance with official instructions.*

Ordnance Specification P.S. 300-4 gives exact specifications for rustproofing materials to be used on Government-owned equipment. Texaco rustproofing products meet Ordnance specifications. They are easily applied by brush, dip or spray, and the protective coating provided will assure preservation for years.

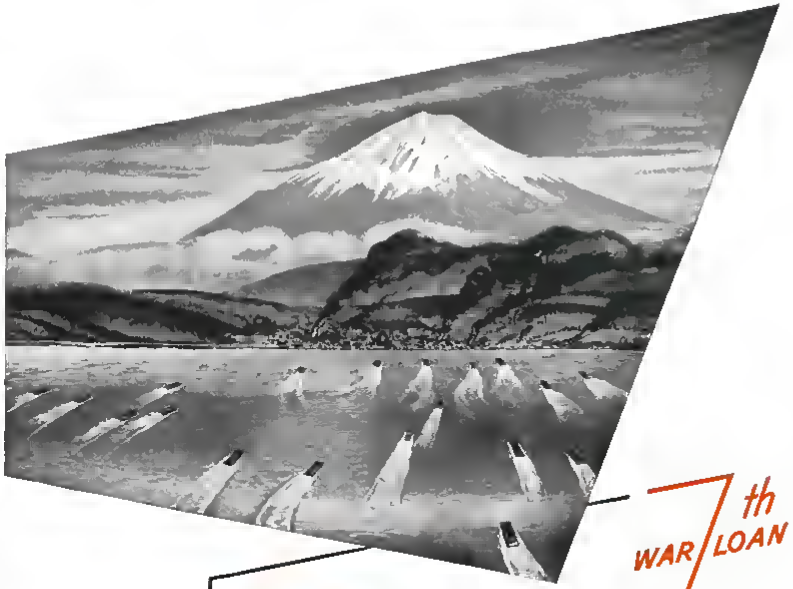
Act now to be ready for prompt reconversion rustproofing of your own as well as Government-owned production equipment when the time comes.

Whatever your rustproofing requirements, a Texaco representative can render helpful service. Get in touch with the nearest of the more than 2300 Texaco distributing plants in the 48 States, or write to The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TUNE IN THE TEXACO STAR THEATRE WITH JAMES MELTON EVERY SUNDAY NIGHT —CBS

TEXACO

TEXACO Rustproofing Products



7th WAR LOAN

We've just begun to fight

Our fighting men have accomplished miracles in the Pacific. Maybe that's led you to believe that Japan is a pushover. Think again. We still have to meet and crush the main body of the Japanese Army *inside the inner Empire.* ■ To do this, we've got to move millions of fighting men—*freshly outfitted and equipped*—halfway around the globe! And *keep* them supplied over vast stretches of water. More of everything will be needed.

This is going to call for more money than your mind can grasp. Money that *has* to come from you. Not later, but *now*—during the 7th War Loan Drive. It'll take the larger part of a month's salary from most of us to meet the quota—in *addition* to the Bonds we're buying regularly. ■ You *can* buy bigger extra bonds just as the Marines found a way to take Iwo Jima. *They* paid in coin they'll never get back. *You* get *yours* back with interest!

Aireon MANUFACTURING CORPORATION

Formerly AIRCRAFT ACCESSORIES CORPORATION

Radio and Electronics • Engineered Power Controls

NEW YORK • • CHICAGO • • KANSAS CITY • • BURBANK

PRECISION!

THE OUTSTANDING CHARACTERISTIC OF

FEDERAL BALL BEARINGS

FEDERAL precision ball bearings are adaptable to every purpose,—aircraft, automotive, industrial, marine. At home, or on distant battlefronts Federals sustain their reputation for precision performance.

Plan now to include these fine ball bearings in your new machines, tools, or products. Federals meet the most exacting requirements of designers, engineers and manufacturers in every important industry.

THE FEDERAL BEARINGS CO., INC.

Makers of Fine Ball Bearings

POUGHKEEPSIE, N. Y.

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STREAMLINE YOUR NEW PLANE DOORS WITH THE

HARTWELL FLUSH LOCK

DESIGNED FOR USE on all types of aircraft doors, including pressurized cabins, the new Hartwell Flush Door Lock gives your plane that final streamlined touch the public will expect postwar.

In the closed position, the *tear drop* handle recesses into the plane door, presenting a smooth, flush surface A push button release slides the handle forward with ample clearance for easy operation.

The lock actuates wedges and spring-loaded, safety catch bolt with the movement of either the outer or inner handle Minimum thickness of doors in which the lock can be installed is 1⅞", and minimum overall depth—handle to handle—is 3". Both outer and inner handles can be recessed in doors having a thickness of 6½" or more

The Hartwell lock is *a basic lock!* It can be tailor-made to meet individual requirements. For detailed information about this air age flush door lock, write: Chief Engineer, Hartwell Aviation Supply Co.

Single source for 779 different aircraft production parts and tools

HARTWELL
AVIATION SUPPLY COMPANY
3417 Crenshaw Boulevard, Los Angeles 16, Calif.
Dallas, Texas • Kansas City, Kansas

Press to release. The spring that slides the handle forward from the closed position is released by push button (A). When extended (B), the *tear drop* handle provides a firm, convenient grip. Only a minimum amount of pressure on the handle operates the wedges. The key lock shown above is an optional item.

One handle does work of two. Either the front or rear handle drives the wedges and spring loaded, safety catch bolt. The first 45° movement of the handle (A) actuates the rotating wedge mechanism. The next 17° movement (B) retracts the safety bolt. When released the handle goes back to a 45° position.

Rear view of lock. The "spider" (A), shown just above the inner handle, actuates the wedge-driving push rod assembly. Provision can be made for as many push rod connecting points as required. Even when locked from the outside, the inner handle will operate the safety bolt and wedges.

STUDY IN PRECISION

This stainless steel aircraft valve involves 32 operations including thread grinding a Class 3 thread, cutting 36 serrations to a P. D. tolerance of ± .0005", grinding inside and outside diameters within ± .0005" tolerance, and various close milling and drilling operations.

May we help you in your post-war precision problems?

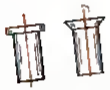
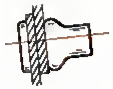
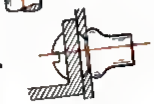
PRECISION *Lawson*

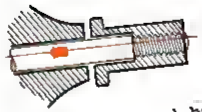
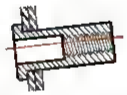
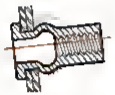
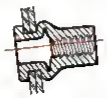
PRECISION

SYMBOL OF PRECISION

LAWSON MACHINE and TOOL CO.
120 MOUNTAIN AVENUE, MALDEN 48, MASSACHUSETTS

RIVNUT...A *simple* BLIND FASTENER

Here are two Rivnuts.  One has a flat head,  the other has a countersunk head.  They are used to fasten with  or to fasten to.  All Rivnuts have a counterbored portion  and a threaded portion. 

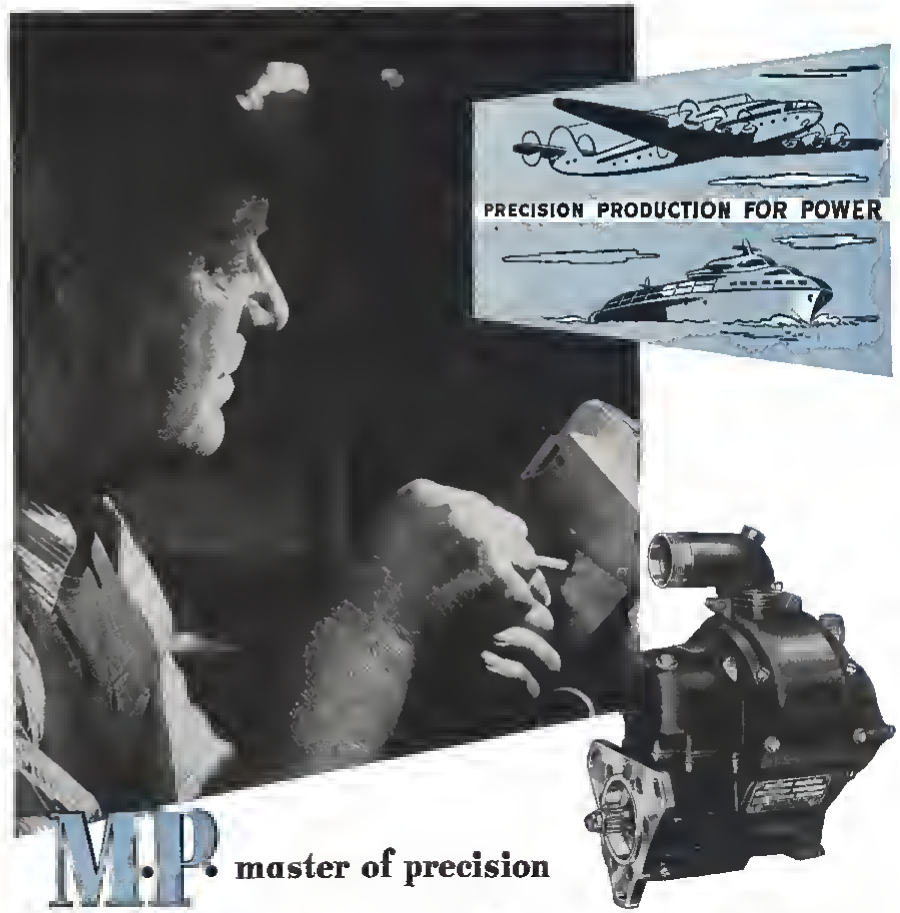
Here's how they upset: Rivnuts are applied with a heading tool that transmits a pull on the threaded portion  so that the counterbore  (which is thinner) has to give. A bulge  starts to form and the threads push the counterbored portion until the expending metal seats itself firmly against the material being fastened.  If the Rivnut will be subjected to torque, just choose a Rivnut with a key  above the bulge. Torque resistance will be increased 100%.

B.F.Goodrich

RIVNUT

IT'S A RIVET...IT'S A NUT PLATE

● Rivnuts are available in a wide range of sizes and grips for different thicknesses of materials. They are now sold only in brass and aluminum. Use of other metals will be announced from time to time. For help in solving your own problems, write to The B. F. Goodrich Company, Dept. AV-6, Akron, Ohio. Ask for new 40-page Rivnut Data Book.



M.P. master of precision

You're looking at one small example of American Bosch Precision Production for Power. This "master of precision" is forming a die from which will flow an endless stream of vital magneto parts.

There are more reasons than one why America's engine builders come to American Bosch. One is the traditional New England craftsmanship. A second is the specialized engineering skill to solve fuel injection, ignition and related problems. A third is the advantages of a world-wide organization which has been built over the years to provide maintenance service for American Bosch products.

American Bosch Magnetos are serving with distinction on many of our great warplanes and in more than 25 other Army and Navy applications.

AMERICAN BOSCH CORPORATION • Springfield 7, Massachusetts

AMERICAN BOSCH

AUTOMOTIVE AND AVIATION ELECTRICAL PRODUCTS • FUEL INJECTION EQUIPMENT

The brightest page in the epic of war is being written by the swift flight of huge mercy ships of the air . . . bringing wounded American boys back to medical care. From the most remote battle front back to base hospital or to the homeland is a matter of a few hours . . . or a day. Thousands who would have died are being delivered . . . back to their families and loved ones, to live out their days. Along with penicillin, plasma and the sulfa drugs, the airplane is the great lifesaver of this war. Douglas workers, builders of planes for the world's airlines yesterday and tomorrow, cherish their privilege today of building wings of deliverance for those to whom we all owe so much.

Douglas

GREATEST NAME IN AVIATION

DOUGLAS EQUIPPED AIRLINES: All American Aviation — American Airlines — American Export Airlines — Braniff Airways — Chicago & Southern Air Lines — Colonial Airlines — Continental Air Lines — Delta Air Corporation — Eastern Air Lines — Hawaiian Airlines — Inland Air Lines — Mid-Continent Airlines — National Airlines — Northeast Airlines — Northwest Airlines — Pan American Airways — Pennsylvania-Central Airlines — Transcontinental & Western Air — United Air Lines — Western Air Lines — A. B Aerotransport (Sweden) — Aer Lingus (Ireland) — Aerovias Brasil S. A (Mexico) — Aerovias de Guatemala S. A — American Airlines of Mexico — Australian National Airways — Avianca (Colombia) — BOAC (British Overseas Airways) — Canadian Pacific Airlines — China National Airways — Cia. Mexicana de Aviacion — Cia. Nacional Cubana de Aviacion S. A — Cruzeiro do Sul (Brazil) — Indian National Airways — K L M (Royal Dutch Airlines) —K N I L M (Dutch East Indies) — UBSIA (Spain) — Panair do Brazil — Panagra (Pan American Grace Airways) — PLUNA (Uruguay) — SABENA (Belgian Congo) — Swissair (Switzerland) — TACA (Central America) — TATA Airlines (India) — UMCA (Central America).

FIRST AROUND THE WORLD — FIRST THE WORLD OVER

FOR AIRCRAFT ENGINES...AN AIRCRAFT SPARK PLUG

Quality ...AND "THE GREATEST SERVICE TO THE GREATEST NUMBER..."

PCA
THE CAPITOL AIRLINE

WASHINGTON NATIONAL AIRPORT • WASHINGTON 25 • DISTRICT OF COLUMBIA

March 16, 1945

BG Corporation
136 W. 52 Street
New York City
New York

Gentlemen:

In recent years PCA's Capital Fleet has been "sparked" exclusively by the BG Spark Plugs. In the many millions of miles which our ships have flown during this period these plugs have performed their part in our operations most commendably.

We're extremely proud of PCA's outstanding operational record. Efficient and economical plugs such as yours have had a part in this record of service.

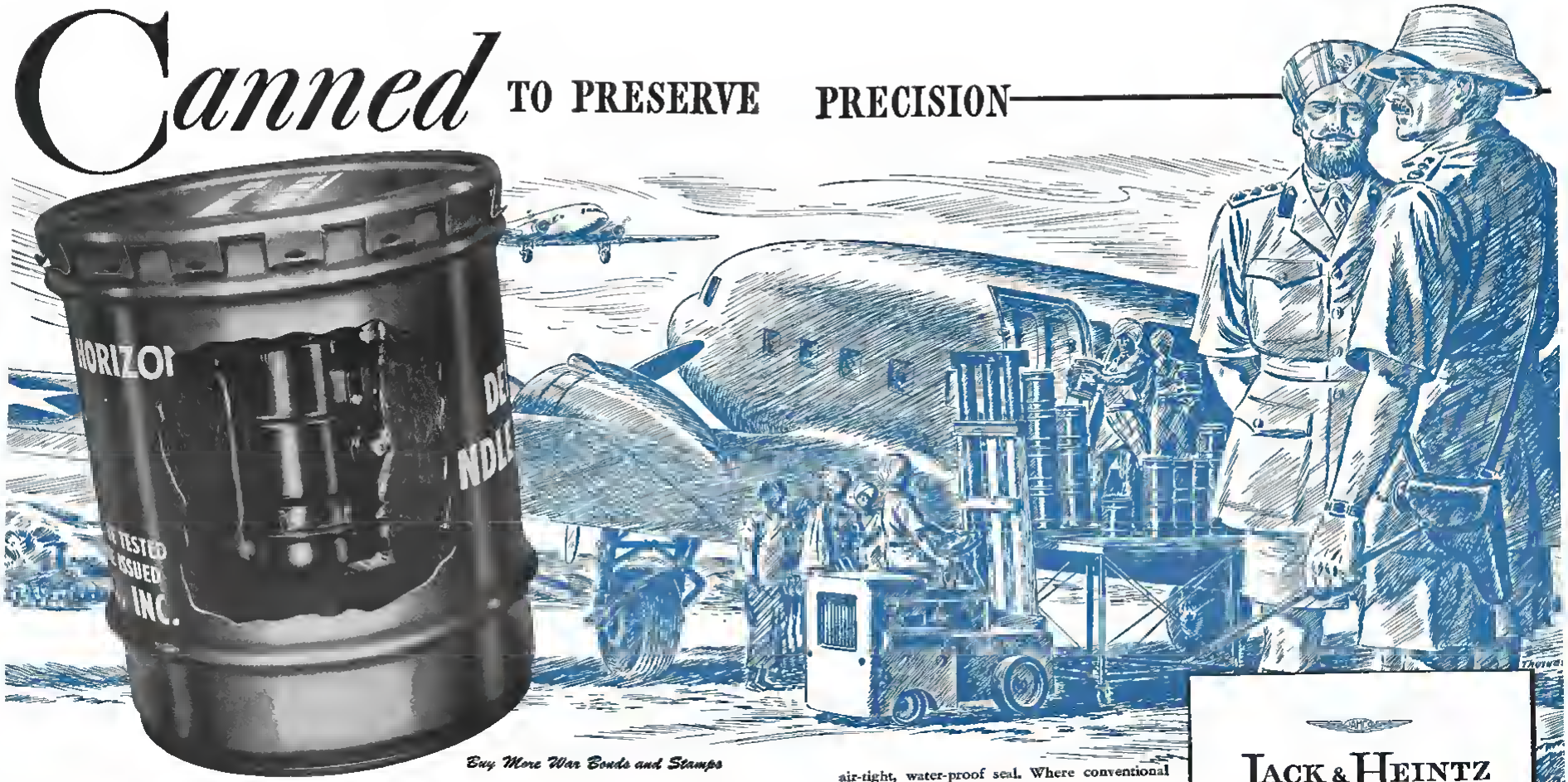
With the extension of our system into New York, with the reactivation of war-suspended routes, with vastly increased schedules through one of the most important industrial areas in the nation, PCA ships must continue to give the greatest possible service. We're going to count on BG Spark Plugs to continue their share in helping PCA fulfill its creed of "The Greatest Service to the Greatest Number."

Cordially,
J. H. Carmichael
J. H. Carmichael
Vice President

BG

THE BG CORPORATION
136 West 52nd Street, New York 19, N. Y.
Manufacturers of both mica-insulated and ceramic-insulated aviation spark plugs
Contractors to the United States Army, Navy and Coast Guard and Aircraft Engine Builders

Canned TO PRESERVE PRECISION



Buy More War Bonds and Stamps

ERROR of a ten thousandth of an inch in the directional gyro might throw a plane far off its course—lose it and all its occupants. Yet such delicate and precise instruments must make long, rough journeys to a war half way around the world—and wait months perhaps before seeing service.

Not satisfied with designing and producing the finest of aircraft equipment, Jack & Heintz engineers were determined to protect it from dirt, dust, moisture, shock—any factor that might destroy its fine accuracy. Working with the Packaging Container Division and the Engineering Division of the Air Technical Service Command, they developed a revolutionary new means of packaging—literally "canning"—to preserve precision.

Precision instruments, starters and generators are floated in rubber-impregnated hair cushion or pulp castings in the can. Silica gel is included to absorb all inside moisture. Then a special J. & H.-developed machine clinches the cover to form an air-tight, water-proof seal. Where conventional packing was good for six months, Jack & Heintz canning protects for a minimum of two years . . . in steaming jungles as well as in sub-zero cold.

This idea, like hundreds of other Jack & Heintz methods, has excellent peacetime applications—export marketing, for example. In the meantime, it will be used to guarantee delivery to our fighting men of all the precision, performance and long life built into vital aircraft equipment by Jack & Heintz.

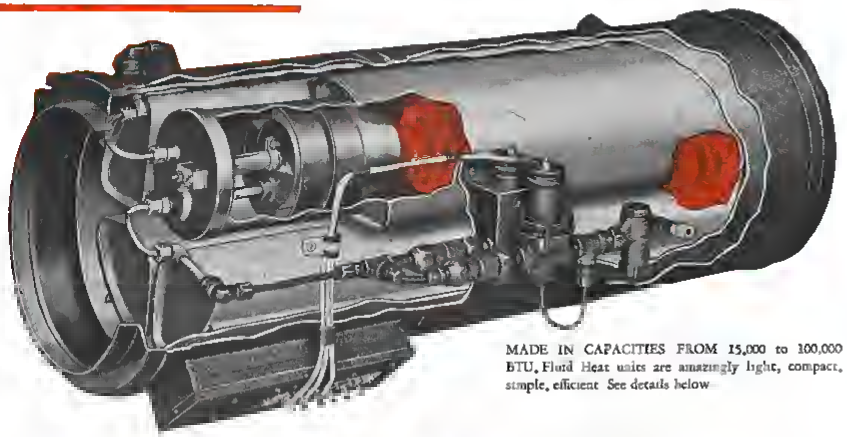
JACK & HEINTZ
Incorporated

Jack & Heintz Inc., Cleveland, Ohio, manufacturers of aircraft engine starters, generators, gyro pilots, gyro flight instruments, magnetos, motors.

NO Moving Parts

NO Nozzle to Clog

NO Flame Variation



MADE IN CAPACITIES FROM 15,000 to 100,000 BTU, Fluid Heat units are amazingly light, compact, simple, efficient See details below

Here's Aircraft Heating Efficiency

from Sea Level to Ceiling

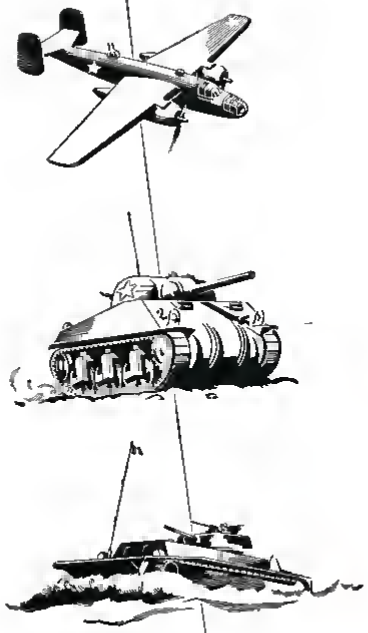
FLUID Heat Aircraft Heaters have all the advantages headlined above—made possible by our exclusive combustion process of Vapor Entraining. And behind this development in aircraft heating stand Fluid Heat's 17 years of leadership in the field of automatic combustion and heat transfer equipment

Utilizing pre-heated combustion air, this *Vapor Entraining Process* accomplishes combustion with an unusually low pressure drop, permitting operation at low ram pressures It produces a completely suspended flame and therefore gives freedom from lead oxide formation Flame retention is so positive that flame characteristics are the same under all conditions And accurate compensation assures high combustion efficiency from sea level to ceiling.

Capacities range from the 15,000 BTU unit, which weighs two ounces shy of 7 pounds, to the 100,000 BTU unit which weighs only 24½ pounds, *and these weights include all controls and accessories* Blowers for ground operation are made for all models, and continuous heating is assured by automatic transfer between ground and flight phase

Naturally, you will want to investigate Fluid Heat Aircraft Heaters for the planes you design, build, equip or operate—*but they are available now only for military use* You may discuss your problems with us in confidence Write to Fluid Heat Division, Anchor Post Fence Co , 6740 Eastern Ave., Baltimore 24, Maryland.

fluid heat
AIRCRAFT HEATERS



Serving on every front!

Landing Craft hit the beaches of a Pacific island . . . TITAN fuel pumps are on the job. Tanks rumble up to crush the enemy . . . many of them depend on TITAN. And there's hardly a plane type used by the Army Air Forces that isn't TITAN equipped. Wherever you find American Armed Forces, you'll also find TITAN fuel pumps, oil pumps, transfer pumps, and Diesel supply pumps.

TITAN
PUMPS

CANDLER-HILL CORPORATION • *DIVISION OF*
TITAN PUMP AND ENGINEERING CORP.
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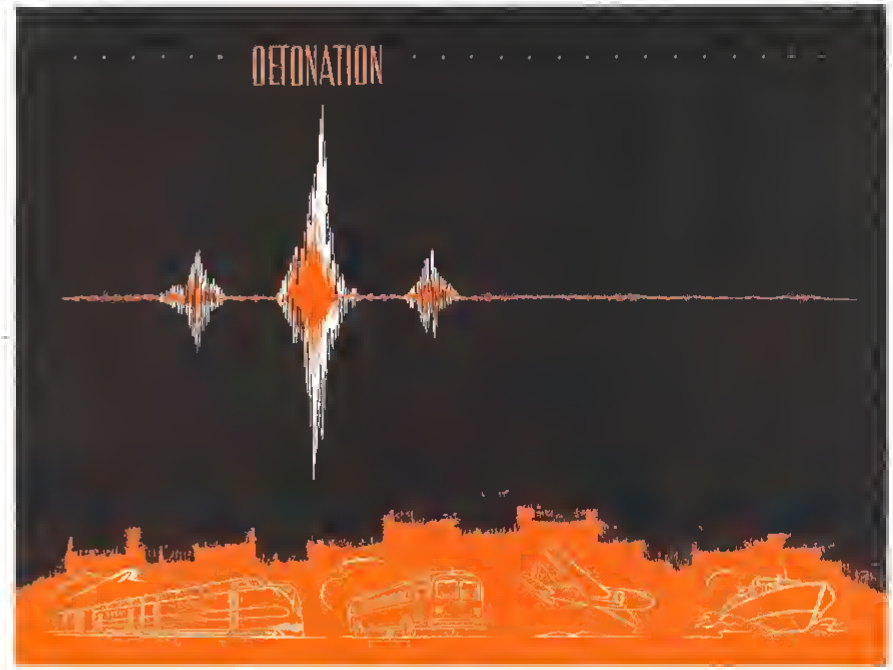
TITAN Pumps are Precision Built by Precisioneers



How electronics helps tell a knock from a boost...

THE MIT-Sperry Detonation Indicator is an engine instrument that discriminates between normal and abnormal combustion.

Through an electronic pickup, it *instantly detects detonation*—popularly called knocking or pinging—in most types of internal combustion engines. And it gives *immediate evaluation of detonation.*

As a result, warning is given at the time trouble *starts* . . . engine life is lengthened . . . mixture may be adjusted so that considerable fuel is saved . . . and the period between engine overhauls is extended.

No piercing of engine cylinders is required. Yet even the slightest detonation is signalled visually, and the faulty cylinder or cylinders spotted.

Use of the MIT-Sperry Detonation Indicator on airplanes results in remarkable fuel savings, longer engine life, greater safety.

The same is true of surface transportation which employs internal combustion engines.

Engine manufacturers find this instrument an invaluable aid in designing and testing. It also permits development of fuels exactly fitted to engine characteristics, thus increasing power output and lowering fuel costs. Also with the Knockometer, a special application of the Detonation Indicator, fuels with superior anti-knock characteristics can be developed and their quality production controlled.

Since 1937, Sperry engineers have been working on the perfection of a detonation indicator. This is but one of the many fields in which Sperry has pioneered in the field of electronic development.

Additional information on the MIT-Sperry Detonation Indicator is available on request.

SPERRY GYROSCOPE COMPANY, INC. GREAT NECK, N. Y.

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Division of the Sperry Corporation

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AIRCRAFT HOSE ASSEMBLIES *must:*

1. Remain pressure-tight under severe vibration and flexing.
2. Resist the action of oil and gasoline both inside and out.
3. Withstand temperature ranges specified by the Air Corps.
4. Resist the action of cleaning fluid externally.
5. Withstand the abrasion of flying pebbles and sand.
6. Be as light as possible consistent with the bursting strength required.

The continued research by Flex-O-Tube engineers over a number of years has been an important factor in the present high state of development of aircraft hose assemblies.

Consult

FLEX-O-TUBE

on any hose assembly application, especially on postwar products.

THE Flex-O-Tube COMPANY

LAFAYETTE at 14th AVE., DETROIT 16, MICHIGAN
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Aeroprops will save places for two

This Propeller's Battle-Tested Lightness Will Be a Payload Factor Soon

WHETHER it's a happy honeymooning couple, or less romantic payload, the pounds Aeroproducts has trimmed from propeller weight will make possible this additional plane capacity for peacetime flying.

Lightness is not the only factor that recommends this General Motors propeller. Its automatic, constant speed operation, simple unit construction, and ribbed-steel hollow blades are among the many features important to flying's future.

Like all General Motors products, the Aeroprop is the result of intensive research, engineering, and production developments. Built to more than meet war's demanding standards, battle-tested on every front, it will be ready to contribute equally to the progress of peacetime flight.

Today the Aeroprop serves flyers who have "dates" with Victory. It will serve tomorrow's honeymooning couples—and others who fly—with the same efficiency.

Aeroprop Advantages—*Lightness* for payload—*Strength* for safety—*Simplicity* for easy service—*Faster Automatic Pitch Change* for flight efficiency—*Full Feathering* for engine protection—*Engineered* for reliability.

Aeroprop

LIGHT · STRONG · RELIABLE

AEROPRODUCTS DIVISION • GENERAL MOTORS CORPORATION • DAYTON, OHIO

Keep them flying—Buy Another War Bond!

UTMOST RELIABILITY OUR GOAL

What ceramic spark plugs have done for aviation is closely parallel to what AC has done for ceramic spark plugs.

Cooperating in the development of the famous Liberty engine of World War I, AC developed and built the *first* ceramic aircraft spark plugs ever produced, achieving a new high in reliability.

Having thus demonstrated the principle, AC engineers made *utmost reliability* their goal, developing ceramic plugs that paced the historic engines of Lindbergh, Maitland, Acosta, Byrd, and (last January) the transport plane "C-97," present holder of the transcontinental record.

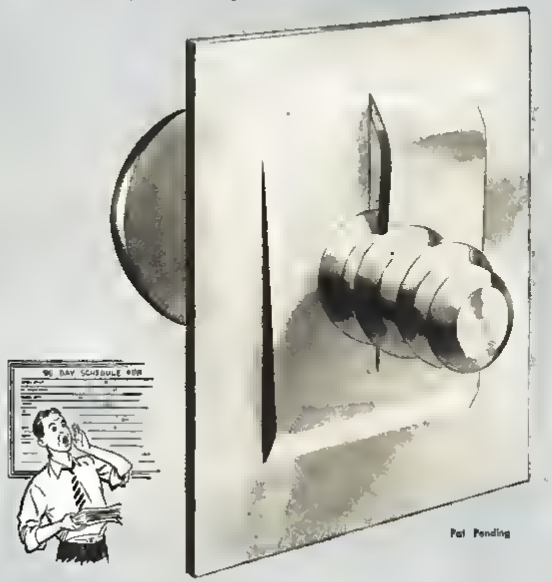
The development of AC ceramics still goes on—in the stratosphere with our bombers—in all seasons and climates with our Army planes—in the wearing routine of commercial planes—in the endless research of AC's scientific laboratories.

BUY MORE THAN EVER IN THE 7TH WAR BOND DRIVE

AC

AIRCRAFT SPARK PLUGS

"Call out" STALOCK*



The "all around fastener"

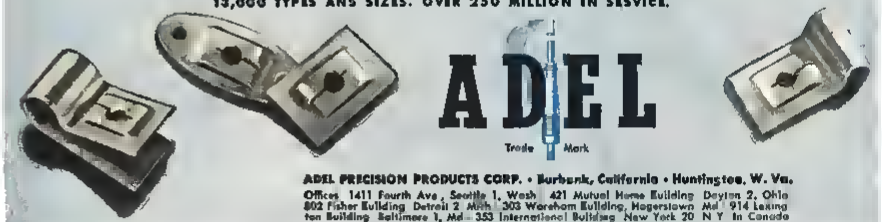
ONE-PIECE
RESILIENT
SELF-LOCKING
RE-USABLE
SAVES WEIGHT
CUTS COSTS AND ASSEMBLY TIME
NO SNASP EDGES NOR VULNERABLE "FINGERS"
AAF RATING (AAF 25533)

Pat Pending

For one-piece, self-locking, resilient, sheet metal fasteners that *stay locked*, "call out" for STALOCK, the "all around fastener". Finds its own way on screw threads. Tightens with screw driver without need of wrench. Eliminates lock washers and bearing washers. Provides "all around" safety, strength, endurance and resistance to vibration. Grips "all around" with 360° thread engagement. **Meets and exceeds specifications (AAF 25533) and has been awarded AAF Rating.** Positive locking action. No sharp edges nor vulnerable "fingers". Saddle, anchor, flat types and a wide variety of other types and sizes are available. STALOCK may be formed as integral part of your assembly. ADEL provides low cost stampings made to your specifications, thus eliminating extra part. **Industrial Users**—investigate the time-saving benefits of STALOCK PUSH-ON fasteners for assemblies using metal or plastic threadless studs, rivets—even nails. For specifications and technical data, write Department N-1501.

Look to **ADEL** for products of *Design Simplicity* and *DEPENDABILITY*

● **MADE BY ADEL—WORLD'S LARGEST MANUFACTURER OF AIRCRAFT LINE SUPPORT CLIPS AND BLOCKS. 13,000 TYPES AND SIZES. OVER 250 MILLION IN SERVICE.**



ADEL

Trade Mark

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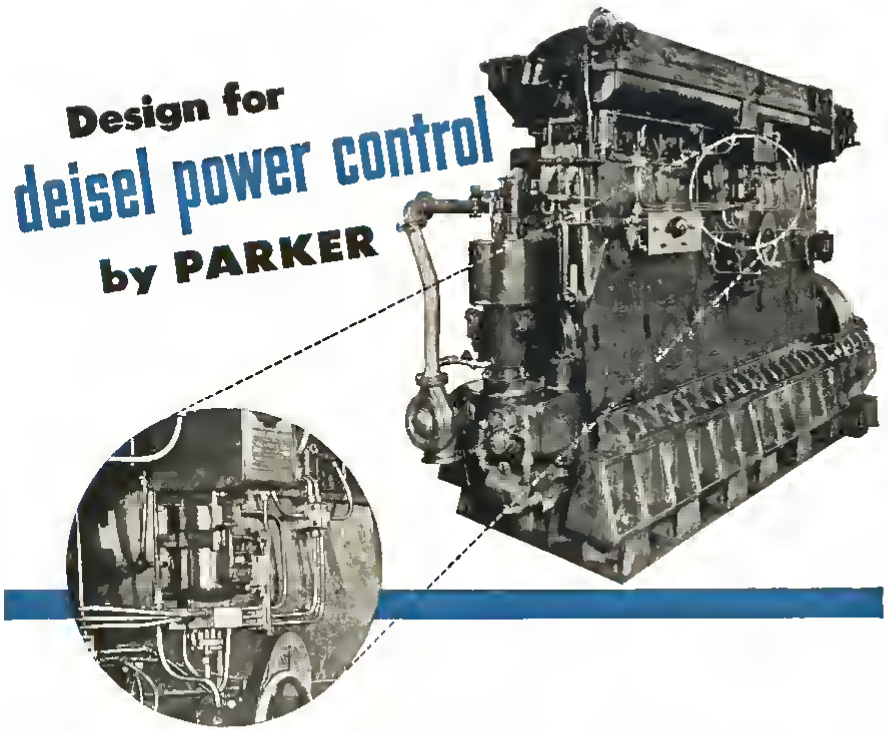
Offices 1411 Fourth Ave., Seattle 1, Wash. 421 Mutual Home Building Dayton 2, Ohio 802 Fisher Building Detroit 2 Mich. 303 Wareham Building, Hagerstown Md. 914 Lexington Building Baltimore 1, Md. 353 International Building New York 20 N. Y. In Canada Railway and Power Engineering Corp. Ltd

*Trade Mark

Design for deisel power control by PARKER



The "nervous" system and the circulation system of a Diesel power plant depend on tubing, with suitable fittings and valves.

Without the tubing installation, the engine can't run. And that's true of many other important kinds of machines.

Designing and building tubing installations, and making their valves and fittings, has been a Parker job for more than twenty years. We call it Fluid Power Engineering.

Parker is ready to supply you with hundreds of types of valves and fittings—all precision-built to precise specifications. Or with completely fabricated tubing jobs, ready to install.

And our Fluid Power Engineers are ready to work with you on plans and designs, with plenty of knowledge and broad experience to draw from.

Parker-Engineered tubing systems provide you with streamlined flow, to conserve power and lessen pressure drop—with compactness and neatness—with ease of access for service and maintenance—and with complete protection against leakage, even under conditions of high pressure, vibration and abuse.

This complete service, or any part of it, is yours to command, for improving present products or in planning for the future.

For more information, or for the service of a Parker Fluid Power Engineer, write to The Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, O.

THE PARKER APPLIANCE COMPANY
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Waldes TRUARC Retaining Ring

Waldes Truarc expands or contracts without distortion and without permanent set, fitting tight all around the groove. It offers important advantages over shoulders, nuts, collars, etc., for all thrust-load fixings in shaft and housing applications. It saves space, weight, assembly time and machining costs. Waldes Truarc presents a significant advance in retaining rings, well worth your thorough investigation. We will gladly furnish samples and full data for tests, upon request.

Internal type National Aircraft Standard 50
External type National Aircraft Standard 51

WALDES KOH-I-NOOR, INC. Long Island City 1, N. Y.
Canadian Representatives: Prance Progress & Engineering Corporation, Ltd., 72-74 Stafford Street, Toronto

Blind date with a Black Widow—

Enemy flyers' acquaintance with the great Northrup Black Widow is usually both short and unhappy. America's famous night flyer—the largest pursuit ship built—is deadly. It has the speed, climb and maneuverability of smaller fighter planes, yet the Black Widow can take off from, and land on, small, dimly lit fields.

For such spectacular performance, the plane naturally depends on top quality materials. The efficiency of its electrical system, for instance, comes partly from a singularly tough and reliable ignition wire built by Auto-Lite. Found in a majority of Allied planes, this wire is fully described in our Form 503A. Write for a copy today.

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★ *20, 40 & 60 TON MODELS*

★ *PROMPT DELIVERY*

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POWER PRESSES

. . . are pushing in press fits on tanks, forming dies for bullets, straightening, bending, and assembling vital parts in the great war plants of the world. They're powerful and they're fast—developing a 60 ton pressure within 4 seconds. Foot pedal controls, adjustable bolster, movable ram heads are features which provide for rapid, efficient, foolproof operation even by women or inexperienced men. Choice of pressures, ram travels, and ram speeds available to meet your specific needs.

WITH *AUTOMATIC PRESSURE CONTROL*

Special pressure control gauges are available sensitive within 100 lb. units up to 60 tons. These will stop ram automatically when pre-set pressure is reached, or may be set to instantly back off work any distance required and then come down again.

WRITE TODAY FOR DETAILED SPECIFICATIONS

LEMPCO

5497 DUNHAM ROAD
BEDFORD, OHIO, U. S. A.

General view of heat-treat department, Tube Reducing Corp., Wallington, N. J. A Rockrite die, used in cold-reduction of the company's "Rockrite" tubing, is being lowered into one of the four big Vapocarb-Hump hardening furnaces

Close-up of operation shown at top of page. Rockrite die, made of SAE52100 chromium steel, is cradled in special furnace fixture, and will be lowered into Vapocarb-Hump furnace for automatically-controlled heating, at specified rate, in Vapocarb protective atmosphere. Quenched on a falling temperature, it will have a Rockwell "C" hardness of 60 to 62, with uniformly smooth surface.

Heavy Production of

DIES AND MANDRELS

Uses VAPOCARB-HUMP Hardening

Heat-treatment of tube-reducing dies and mandrels is in many ways a production job, rather than a series of tool-room problems, in Tube-Reducing Corp.'s plant. Jigs and fixtures standardize the placing and handling of the large numbers of tools in the furnaces and quench. Records of performance are guides in maintaining standard procedures, and, wherever possible, all controls are automatic.

A central factor in securing uniformity plus automatic control is use of the Vapocarb-Hump Method for hardening. Four large Vapocarb-Hump furnaces assure the same protective atmosphere for all dies and mandrels, so that pitting and scaling are equally prevented. The Micromax recording controllers, each with its two sensitive, carefully-placed thermocouples, show temperatures of both dies and furnace walls and enable heating to be held to any desired rate or soak point. Micromax records are easy to inter-compare, and results obtained in one furnace can be duplicated in any other.

Our compact, well-illustrated Catalog T-621 gives a complete words-and-pictures description of the Vapocarb-Hump equipment and the results it is helping users secure. A copy is free on request.

"Saw the heavens filled with commerce"

The world has grown up, aerodynamically, over night. Tomorrow's airliners and cargo ships—overseas leviathans and family flyabouts are here. Hovering helicopters and jet propelled planes are out of their swaddling clothes and on the production line. America is ready to take to the air.

Because war can't wait—airplanes have made technological advancement that would have meant years—perhaps decades of development under peacetime progress. In the matter of aircraft engines alone, not only has horsepower been tremendously increased, but entirely new principles in propulsion have been developed.

Today Foote Bros. "A-Q" (aircraft quality) gears are serving in the engines that power fighters, bombers and transports. Producers of the revolutionary helicopter and jet propulsion engines also rely on "A-Q" gears to help solve difficult problems in power transmission.

These gears represent a new advance in design and production methods. They assure greater mechanical efficiency, lighter weight, quieter operation, greater compactness. Applied to the machinery and equipment you are manufacturing or planning to manufacture, they will assure many competitive advantages—help you solve many engineering problems. Foote Bros. engineers will be glad to consult with you on the application of these new developments in power transmission to your product.

FOOTE BROS. GEAR AND MACHINE CORPORATION, Dept. G, 5225 S. Western Blvd., Chicago 9, Ill.

A copy of this informative product engineering manual on "A-Q" gears will be sent to you on request. Write for copy.

FOOTE BROS.

Better Power Transmission Through Better Gears

"Dang these one-wheel landings..."

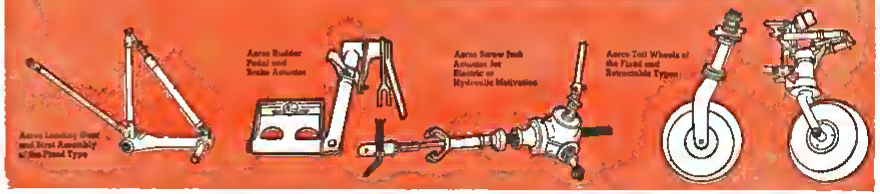
There's a sure way to fix that... Aerco actuators won't let you down on one wheel. Reliability and performance are built in—built in by years of experience in producing landing gear assemblies for Army, Navy, and civil aircraft installations. Aerco actuators are available with either hydraulic or electric motivation.

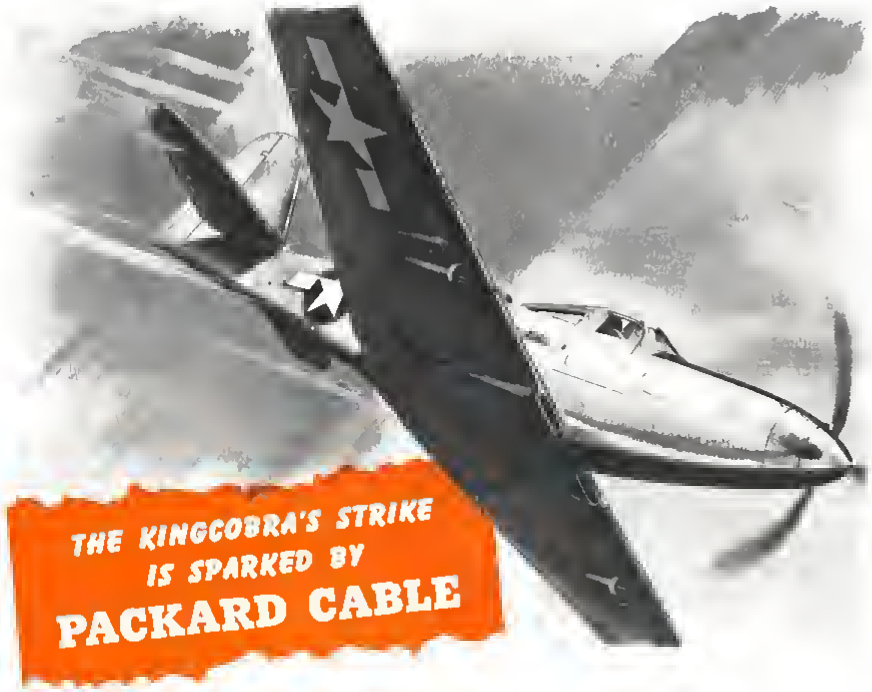
Whether you need simple tail wheels, or complete landing gears of the conventional or tricycle types, Aerco engineers and facilities are at your service. Inquiries invited.

AERCO CORP.

HOLLYDALE, CALIFORNIA

TYPICAL AERCO PRODUCTS





THE KINGCOBRA'S STRIKE IS SPARKED BY PACKARD CABLE

Deadly in its speed, striking range and firepower, the Kingcobra requires ignition cable that will perform satisfactorily under all atmospheric conditions, from sea-level to ceiling, in all parts of the world. Its ignition cable must resist the deteriorating effects of abrasion, oil, age, heat and corona . . . must withstand rapid changes in temperature and humidity.

Packard high-altitude aircraft ignition cable meets these requirements. The tough synthetic rubber sheathing, over an inner reinforcing braid, withstands extreme conditions of use . . . provides effective protection wherever the best and most reliable high-tension cable is required.

Packard has met the challenge of stratosphere flight, serving not only in fighters and bombers, but in commercial planes as well. Packard cable delivers the current when and where it's needed.

Packard high-altitude aircraft ignition cable is available with either copper conductor or stainless steel conductor. You're RIGHT with Packard cable.

KEEP BUYING BONDS

Packard

PACKARD ELECTRIC DIVISION
GENERAL MOTORS CORPORATION
WARREN, OHIO

A second star has been added for continued excellence

Packard cable serves the armed forces on trucks, jeeps, armored cars, planes, aircraft instruments, anti-aircraft gun controls, landing craft, radio equipment.

THE "WHO'S WHO" OF AMERICAN AIRCRAFT FLY WITH PERSONS CONTROLS

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C-46 COMMANDO
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B-29 SUPER FORTRESS
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Each of these famed planes depends upon Persons for:

Lighter, more compact construction • Rugged, vibration-proof design • Extremely fast, sensitive action • Utter dependability.

FOR BETTER AIRCRAFT CONTROLS WE ARE THE "PERSONS" TO SEE

Only a few typical PERSONS products are shown here. Send for our catalog—or consult our engineering department for special applications.

L. M. PERSONS CORPORATION

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MIGHTY MITE!

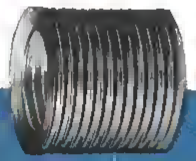
THAT TINY OBJECT there in the man's palm—that's a Sylphon Bellows. When fitted with proper heads and charged with a thermo-sensitive liquid it becomes a thermostat—a powerful little "motor" deriving its power from changes in temperature of the confined liquid. Without the liquid charge, the assembly could be used as a pressure "motor." In either case the developed power could be employed to "make" and "break" electrical circuits, open and close valves, dampers, etc. —in fact its usage is virtually without limit.

This particular Sylphon Bellows is only ¾ inches in diameter yet it's so rugged that it can withstand pressures up to 315 pounds per square inch. Other sizes and types available for even higher pressures.

Together with its larger and smaller companions, this mighty mite is ready to fit into your post-war plans —simplify and improve existing designs—possibly be the key to revolutionary new developments.

* * *

Write for the complete story—Bulletin No. LA-1300 contains valuable data which should be useful to every engineer. A copy will be sent upon request.



FULTON SYLPHON

TEMPERATURE CONTROLS BELLOWS BELLOWS ASSEMBLIES

THE FULTON SYLPHON CO., KNOXVILLE 4, TENNESSEE

IDLE FOR MONTHS -YET READY FOR INSTANT USE

1. Early in the war we learned that stored aircraft engines showed rust and corrosion on internal parts even though effectively sealed on the outside against weather conditions. This was caused by moisture forming on cylinders, valves and other machined surfaces by condensation from the air.

2. To prevent this internal sabotage, Union Oil Company developed outstanding, revolutionary STOP RUST B . . . a compound which forms a non-drying, non-hardening film that adheres to metal for an indefinite period, completely sealing every working surface against rust and corrosion.

3. Engines protected with STOP RUST B are ready for instant use. There is no need for special cleaning or servicing, for this new product mixes readily with all commercial lubricants. Because of its detergent qualities STOP RUST B, mixed with oil as recommended, will keep engines clean and free from sludge.

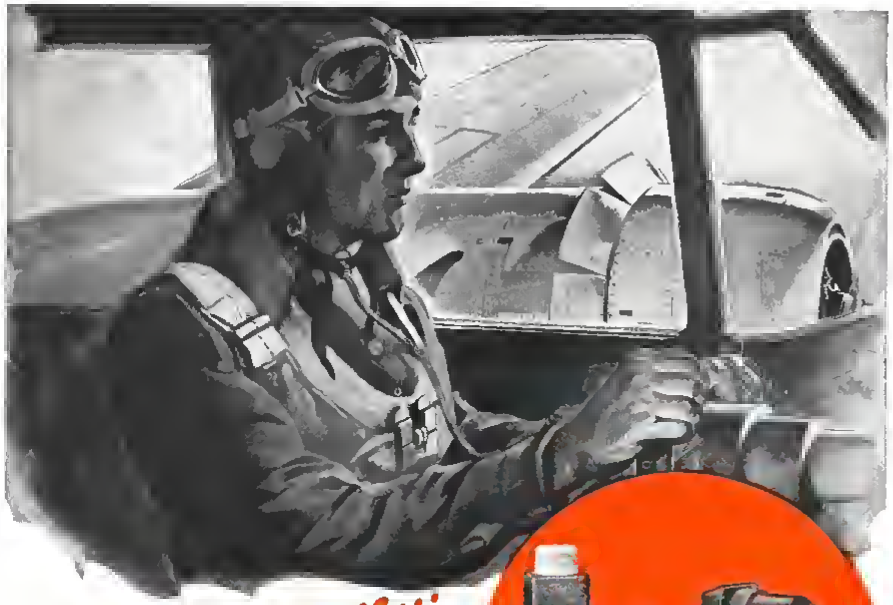
4. So successfully does STOP RUST B meet all requirements for internal rust prevention that it is now used by the leading Pacific Coast aircraft companies to protect engines in storage and awaiting shipment. It meets specification AN-VV-C-576a and is used in accordance with standard military instructions.

Get a supply of STOP RUST B . . . It will protect your idle engines from rust and corrosion, keep them clean, and permit instant use. Phone your local Union Oil representative, or write Union Oil Company, 617 W. 7th St., Los Angeles 14.

STOP RUST B

UNION 76

Another **UNION OIL** *Success-Tested Product*



An open and shut case...

AN ELECTRIC MOTOR opens and closes cowl flaps on the new Douglas A-26 Invader to maintain proper engine temperatures under varying conditions of minus 70° F to plus 140° F and from sea level to the optimum altitude of this versatile attack bomber.

The electric cowl flap actuator, one of the seven special motors designed for the A-26 by EEMCO, is a good example of how an electric motor, gear reduction and control unit can be built to fit awkward mounting conditions in limited space. As furnished for use in a 28 volt system, this motor actuator complete weighs only 4¾ pounds. The nearest competing weight in a motor unit of this type is seven pounds. Similar design problems confronted EEMCO in building the wing flap and oil cooler door drives, the gun mount trigger motors and the cabin heater blower motors for the Invader.

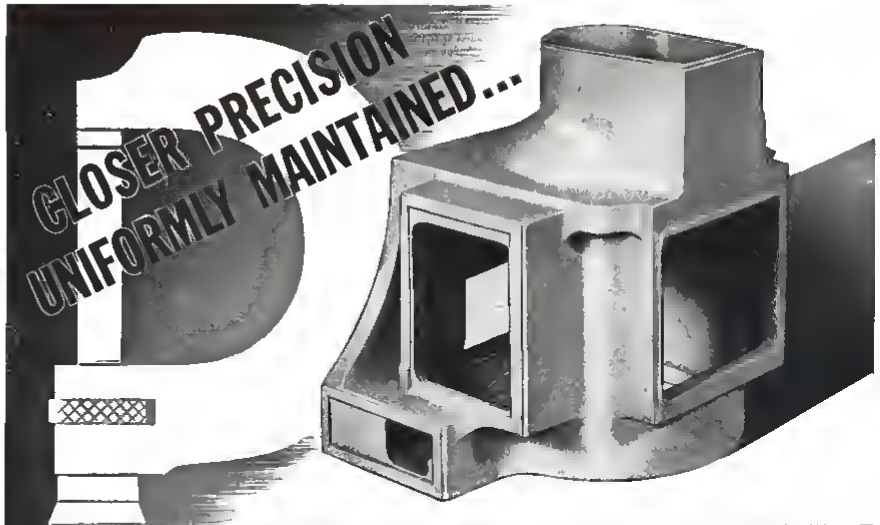
New developments in electric motor manufacture indicate greater application possibilities than ever before in future peace time products. If you have tough work problems involving electric motors, gearing and control, let EEMCO help you solve them—now for war work, later on for peace time service.

DATA. Cowl flap actuator, ⅙ horse power motor, thermally protected — Equipped with magnetic clutch and brake — Shaft output is 8" pounds at 1200 rpm — Straight 8 to 1 gear reduction is provided for opening and closing flaps, with double reduction and worm drive to operate cams limiting travel of flaps — Unit completely self-contained.

Names are being put on the reserved list for "Custom Built Motors for a World of Needs," now in preparation. Copies of this limited edition will be distributed only on written request.

EEMCO

ELECTRICAL ENGINEERING AND MFG. CORP.
4626 West Jefferson Boulevard, Los Angeles 16, California



...AND ALL CASTINGS FROM THE SAME MOLD

When your castings are made by the permanent mold technique, you may be sure of the utmost precision in following your design. For the permanent metal mold operates with a dimensional tolerance of only ± .010", compared to ± .030" in sand casting.

And this precision is uniformly maintained, no matter how many castings are poured. For, as the same molds are used regardless of the number of castings poured, there is no opportunity for dimensions to vary. **Right** in the first place, these castings **stay right** all through the run. Metal surfaces also promote rapid cooling, with finer grain and greater tensile strength.

Aluminum Industries has had nearly 25 years' experience in the making of permanent mold aluminum castings. We know of no foundry with better facilities or more modern equipment. And to our casting "know how" we add a thorough knowledge of aluminum and its alloys.

One of our technical representatives will be glad to visit your plant and demonstrate how permanent mold castings cut down finishing time and costs. And remember – Permite permanent mold castings may be just what you are looking for to get the jump on competition in the postwar world. Consult us regarding your requirements.

ALUMINUM INDUSTRIES, Inc.
CINCINNATI 25, OHIO

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PERMITE ALUMINUM ALLOY CASTINGS

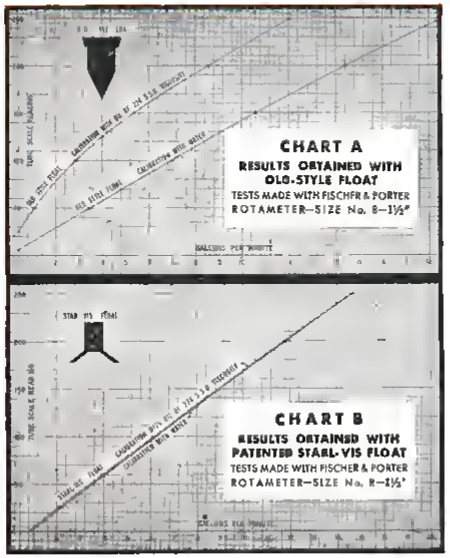
HERE'S THE Amazing Proof

of

Viscosity Compensation in Flow Rate Measurement

with the

STABL-VIS ROTAMETER



Prior to the development of the Stabl-Vis rotameter, accurate flow rate measurement of viscous fluids was impossible except with automatic temperature control or a whole series of painstaking calibrations covering every few points of change in viscosity.

Charts "A" and "B" prove how the Stabl-Vis rotameter has removed these difficulties.

Chart "A" shows calibrations for water, and for oil with a viscosity of 224 S.S.U. using a size 1½" rotameter with an old style float.

The average error introduced by the change to viscous oil from water is 33⅓%, based on the water flow.

Chart "B" gives calibration for water and the same oil of 224 S.S.U. with the Stabl-Vis rotameter. The curves are drawn apart slightly to show there are two curves. Actually, they practically duplicate one another. The change from water at 31 S.S.U. to oil at 224 S.S.U. has been made while maintaining a calibration accuracy of 99.5%.

For you in the Aviation Industry this proof of the metering accuracy of the Stabl-Vis rotameter has great significance. It means that flow rates of gasoline, hydraulic oils, lubricating oils, de-icer liquids, coolants and other important fluids may be determined instantaneously with great accuracy.

The Stabl-Vis rotameter can be made for low or high pressure and for direct reading or remote reading. It is adapted to ground test or plane installations as desired. It has become the standard flow rate meter for the aircraft industry.

The theory and design of the Stabl-Vis rotameter is told in our catalog 98-Y. The meters that we build for use in aviation with the Stabl-Vis features incorporated are described in catalog 63-G. Write for these bulletins — we will gladly send them to you without obligation.

FISCHER & PORTER CO.

306 COUNTY LINE ROAD, HATBORO, PA.

F&P ROTAMETERS

RATE OF FLOW INDICATING, RECORDING OR CONTROLLING ROTAMETERS FOR ANY LIQUID OR GAS

CAN IT BE MADE BETTER FOR LESS?

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Solving Problems for Industry

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★ O-A HOSE END FITTINGS
★ BRAISED STEEL FITTINGS
★ HYDRAULIC BRAKE LINES AND BRAKE FITTINGS
★ FIRE RESISTANT HOSE ASSEMBLIES
★ THE WEATHERHEAD SEAL

Legion are the manufacturers looking for new and improved ways to build new and improved products for the coming peacetime markets.

Here at Weatherhead we build the parts that go to make up such products. And ever since 1919 the growing number of Weatherhead research, design and production engineers have been creating parts of greater demonstrated uniformity—dependability—efficiency—parts that have become a "must" in many a plant . . . lowered the cost of many a product! They are parts that *work better* and *still cost less.*

One of many examples:—the new Weatherhead "Quick-Attachable" (Q-A) hose end fittings have proved a boon to aviation mechanics everywhere. They are assembled with equal ease in shop or field, without special tools, with tremendous saving in installation time. They are reusable and have almost limitless applications in other fields.

If the parts for your coming peacetime products can be made "better for less," Weatherhead engineers will know. Write our Sales Engineering Department today for assistance in solving your problems.

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Remote-indicating Compass

THE remote-indicating compass was developed because much of the equipment in the cockpit of a plane seriously distorts the earth's magnetic field, and therefore renders inaccurate the reading of a conventional direct-reading compass.

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In building this remote-indicating compass, General Electric has applied its wide experience in the development and application of new magnetic materials. The result is a highly accurate system on which the pilot can depend.

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GENERAL ELECTRIC

Axis Airmen Can't Wriggle out of these Deadly Grips!

Handfuls of Power! With one of these Martin *plastic* grips in each hand, Allied aerial gunners can swing turrets in vertical and horizontal planes, control gunfire, even regulate intercommunication system.

Martin plastic hand grips give gunners greater accuracy

Stepping up accuracy of fire, reducing fatigue strain on aircraft gunners, Martin plastic hand grips are an important factor in maintaining and increasing Allied aerial superiority. Used on Marauders, Marylands, Baltimores, Coronados, Liberators, Havocs, Venturas, Invaders, Black Widows, the training turrets of Beech aircraft and on such British planes as Lancasters, Bostons and Sunderlands, these grips have helped account for more enemy aircraft than any other type of control.

Unlike metal grips, which freeze to the gunner's hand at high altitudes, the Martin plastic hand grips give maximum efficiency at all altitudes. Gunners have only to swing the grips right or left, up or down and the turret responds instantly, keeping the target in the sights. Extended and indented to fit the hand, they insure greater comfort and ease of operation—while providing firm braces for the gunner to grip when the plane bucks or pitches. When used in the famous Martin aerial turret, they give our gunners one of the war's most deadly weapons.

These plastic hand grips are typical of the many developments which have been perfected by Martin to improve both performance and production of Allied warplanes. Today pledged to war, Martin skill and ingenuity will, in the days to come, make major contribution toward building a more abundant world.

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Martin AIRCRAFT

Builders of Dependable Aircraft Since 1909

How to choose the right tire for new airplane designs . . .

B. F. Goodrich service to designers offers engineering help in choosing best tire for any airplane

THE SELECTION of the right airplane tire for the job affects airplane design in many ways. For example, tires with higher pressures can be smaller, more compact for the load they will carry. Or, consideration of the extra safety factor through the use of duals in some types of service may be vital, while in others the greater braking surface provided by a smooth-contour design may be the answer.

B. F. Goodrich Low Pressure evolves into new Type III

All the factors of airplane tire design have grown to the point that it is no longer possible to draw the line between tire types by referring to high pressure, low pressure types. The first "low pressure" tire for airplanes was engineered by B. F. Goodrich. It remains today probably the most efficient type of tire for general air transport and cargo service. But some sizes carry comparatively higher pressures today. The distinguishing characteristics of the tire are its superior wear life, cushioning and safety. So the new designation, Type III, has been established as representing these general features

Other types

Other types of tires are specially designed for different tire uses. Shown on this page are cross sections of the three most important types, with a general outline of their characteristics.

TYPE I
(Smooth contour)

Good aerodynamic efficiency (where that is a factor) plus good load capacity per pound of tire. Provides sufficient wheel diameter for extra brake capacity. Wheel weights are high as compared to other types and this type cannot be used on thin wing planes where retracting space is limited. Type I tailwheels, because they do not require brakes, have relatively smaller wheel diameters

TYPE III (Low pressure)

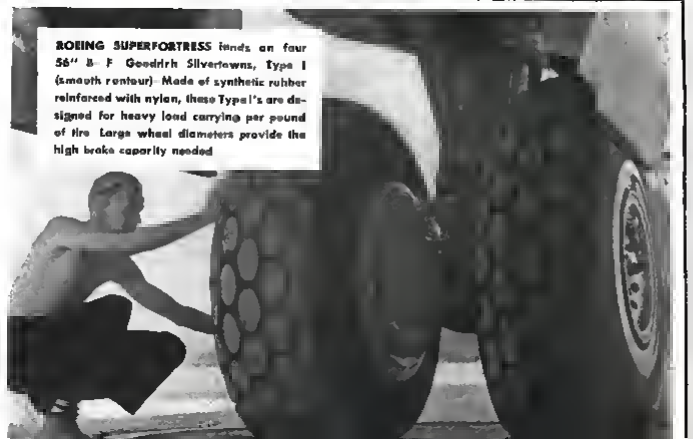
A good tire for transport or cargo airplanes, and for non-tactical military and private planes. The section width is slightly larger than the Type I tire for a given outside diameter, but the bead or inside diameter is smaller than Type I. This permits a larger air volume, lower inflation pressures and greater footprint

For wear, cushioning and safety, Type III tires are generally superior. For comparable outside diameters, they will generally weigh more than the Type I, but the smaller wheel diameters will compensate for this increase in weight

TYPE VII
(Extra high pressure)

Recommended as most efficient for most tactical military planes, when performance in the air is the prime consideration. Designed to provide a tire with a very high load capacity for its size and weight plus a narrower section width to permit retraction into latest design thin wings

Full facts in new catalog . . . Latest edition of The B. F. Goodrich Aeronautical Products Catalog contains complete tire data—sizes, types, characteristics, etc. Also helpful facts on De-icers, fuel cells, brakes, hose and many other rubber products for aircraft. For your copy, write to The B. F. Goodrich Company, Aeronautical Division, Dept. A6, Akron, Ohio.



BOEING SUPERFORTRESS lands on four 56" B. F. Goodrich Silvertowns, Type I (smooth contour). Made of synthetic rubber reinforced with nylon, these Type I's are designed for heavy load carrying per pound of tire. Large wheel diameters provide the high brake capacity needed

Skyway or Highway

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FIRST IN RUBBER

RUSSIA AND AMERICA

ALLIES—or else . . .

VICTORY in Europe was won only through the combined endeavor of the United Nations. Only through sustained joint effort can the fruits of that victory be reaped.

Without disparaging the truly heroic contributions of others, three of the Allies may fairly be credited with having made the major contributions to victory over the European Axis—the United Kingdom, Russia, and the United States. The close accord of these three nations is no less crucial to the accomplishment of the tasks that remain.

First of these is the war against Japan. It still requires winning. Even without any help from others, the United States could make good this victory, but the war's duration will be speeded by the marshaled effort of the United Nations.

Next, and not less important, is the task of establishing a basis for enduring peace. In this struggle our enemies are more formidable than any we have faced—national ambitions, prejudices, suspicions and distrusts, the staggering burden of tradition and debilitating cynicism born of past failure, the cleaving wedges of divergent languages, thought patterns, economic creeds and procedures—an array of difficulties as baffling as fog and as formidable as a deluge. They can be vanquished only by a continuance of the working accord between the United States, Russia, and Britain that was forged on the anvil of European conflict.

☆ ☆ ☆

This high appraisal of the decisive importance of the Big Three in determining the destiny of the United Nations organization, in no way depreciates the importance of the role to be played by France, by China, or the other freedom-seeking nations represented at San Francisco. All of us are committed to the building of a genuinely representative security organization in the conviction that by such means alone can we possibly achieve a just and lasting peace. But the strength of any international machinery will depend upon the validity of Russian-British-American cooperation. If these three are able to achieve substantial harmony of aim and procedure, a world organization that includes them can operate with effective coherence. If they pull apart, the United Nations will break up into competing and jealously hostile blocs.

This is inevitable because of the sheer weight of these three nations in the world's affairs. Between them they account for perhaps half of the world's income and from two-thirds to three-quarters of its industrial output. Once Japan has been crushed, they will control an overwhelming preponderance of the world's armed might. Each of them will wield military power on a scale quite beyond the power of any embryo security league to hold in check. Only if all three are resolved to keep the peace and to enforce it through the Security Council, can that body hope to accomplish its aim.

Although there is a tendency on both sides of the Atlantic to indulge somewhat recklessly in mutual criticism, the ties between Britain and America are too firm to be severed by any foreseeable strain. But that has not been true of our relations with Russia. Even while fighting a war in which our respective ways-of-life were at stake, the inestimable services of each to the other were rendered as friendly but independent associates rather than as fully trusted partners. Now again, as we approach the difficult and vitally important task of building a world organization and of devising a European peace, the task of our delegates is complicated by national attitudes under which each hopes for the best from the other, while fearing the worst.

But the stakes for us both—and for the rest of the world—are too high to be played for in a diplomatic poker game. Russia has no inhibitions in demanding what she wants, and our own vital interests must be stated and upheld with undeviating firmness. Yet we both must face the stark fact that few advantages that either nation might gain at the cost of dissipating the good will of our wartime association could be worth the price thus paid.

☆ ☆ ☆

The first steps toward establishing confidence lie in a frank recognition of what may contribute to the lack of it and in a definition of what can be done to restore it.

1. *Probably the greatest single area of reciprocal distrust between Russia and our own country is based on the fear of each that the other may try to interfere with its domestic, economic, and political affairs.* Each purports to see the beam of meddlesome intervention in the other's eye, while it ignores the mote in its own. Thus the Soviet Union remembers that we participated in the foreign military intervention at the time of her civil revolution, and afterwards lent our support to successive boycotts of her trade, of her gold, and of her credit needs. For our part, we remember the Soviet Union's doctrine, and

aggressive support, of revolutionary international communism.

We feel that Russia should find satisfactory evidence of our present willingness to have her develop her internal institutions as she will in the aid that we have given her during the war, and in the record of our good-neighbor policy as applied to Latin America. She, no doubt, resents our lingering suspicions in the face of her declared policy of 1941 to refrain from any attempt to influence the political or economic structure of foreign nations. Certainly, each of us will need the repeated reassurance that can come only through sustained performance by the other in the years ahead. Meanwhile, much will be gained if each will give to the other's good faith the benefit of the doubt, while it scrupulously guards its own conduct to avoid even the appearance of backsliding.

2. *A second zone of suspicion is created by those measures which each of us interprets as natural and necessary bulwarks of national security when they are our own, but as evidence of dangerously aggressive imperialism when taken by the other.* In our view, at least, such demands as we have voiced for island trusteeships or for other naval bases appear mildly conservative as compared with Soviet claims for annexation of territory and for a general orbit of influence, under governments friendly to her, throughout eastern Europe in particular.

There can be no easy solution to that problem. Bi-focal vision, by which one nation can look through a second lens ground to the prescription of another, seldom is achieved in international affairs. The success of the San Francisco Conference will provide a mechanism for international definition of principles and procedures which at least might relieve the inevitable strains. Most important will be the record of how each of us proceeds in our respective courses of action. Soviet performance thus far is highly unsatisfactory to us. While we have taken pains to clear our procedure with her, she has taken action in the Baltic, in Austria, and in Poland without even advance notice to us.

A major test of our ability to cooperate may be found in the Allied administration of conquered Germany. The proposed four-headed control of a four-way partitioned nation promises to be at best an extremely awkward mechanism of administration. At worst, it can result in continuous and dangerous bickering between the representatives of Britain, France, the United States, and Russia in the Berlin coordinating center, and in hopelessly divergent procedures in their several zones of administration. There will be a compelling need for all of us to exercise all of the wisdom and cooperative resolve that we possibly can muster.

3. *A third testing ground for the future of American-Soviet relationships will be defined by the course of Russia in our continuing war with Japan. We are not unmindful of the toll paid by the Soviet Union in its magnificent European war effort. But we still are locked in a desperate struggle with an enemy that exemplifies the Fascism which America and Russia equally denounce. And that war is being fought in an area where Russian interests are importantly at stake.*

Russia has an extraordinary opportunity to create good will by throwing her weight speedily and effectively on our side. There is no doubt but that the final Pacific settlement will generate problems comparable with those of the European peace, but it is equally certain that the continuation of the European comradeship in arms can do much to promote an enduring and confident postwar friendship.

4. *A fourth, and highly important, potential source of suspicion and irritation is the intellectual blockade that the Soviet Union has maintained against the free flow of travel, intercourse, and exchange of ideas.* We can understand the genesis of this policy and the reasons for its continuance while Russia entertained a constant fear of attack by powerful enemies. But the sustained perpetuation of such a quarantine by so strong a nation as the present U S S R. could not be accepted as a protective measure. Inevitably it would generate suspicion that it was rather an instrument of nationalistic isolation or even of contemplated aggression. A way-of-living, at arm's length, with a nation that maintains such intellectual quarantines is possible; any whole-hearted partnership of effort is quite impracticable.

5. *Trading between a free-enterprise nation and one that operates all foreign commerce as a government monopoly can give rise to many frictions.* That subject is too complicated for exposition here. Suffice it to say that, while difficult, it is not impossible to conduct such trade with mutual advantage. We are in a position to help Russia greatly with her program of industrial rehabilitation and expansion at great saving of cost in terms of her current scale of living. In return, we must have assurance that her government monopoly trading will be conducted for commercial rather than political ends, and that it will be used to encourage rather than to restrict multilateral and non-discriminatory world trade.

* * *

This is a representative list of the major areas in which misunderstanding and distrust may be generated, or allayed, in Russian-American relationships. No doubt, an equally honest list drawn by a citizen of the Soviet Union would be more heavily weighted by those features of our behavior which irritate and stimulate distrust on their side. If such a catalog were to be presented, it should receive our most searching and responsible consideration.

For it is of utmost importance that our two nations, in concert with the other United Nations, learn how to get along in mutual confidence and respect. Our understanding of each other now is so imperfect that our negotiations are punctuated with continuous irritations over *little issues.* This, inevitably, will continue until such matters are submerged in the general confidence that can be achieved only through satisfactory settlement of the *big issues.* We must succeed in this, or the defeat of Japan will merely mark the end of the Second in a series of World Wars.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Co., Inc.

THIS IS THE 36TH OF A SERIES

EDITORIAL

FOUR IMMEDIATE STEPS TO PERMANENT PEACE

ONCE AGAIN the inevitable course of history has exploded the superman myth. Once again events have proved that crime among nations as among individuals, does not pay. But if crime doesn't pay it *does* cost. In our sober reflections during the period between victories we should try to evaluate that cost to date in casualties, in dollars, and in the social and economic implications of the greatest of world upheavals so far.

In the flush of a major victory it is easy to forget our earlier defeats. It is easy for us, as survivors of this phase of the war, to don our own superman cloaks and assume that we are unconquerable. If we allow ourselves that luxury, even for a single moment, the outcome of our war with Japan and the whole future of the nation is in grave doubt.

There have been times in the course of this first phase of the war when we were very close to defeat. If we had started later than we did to build up our air forces we might possibly have muddled through—but at a far greater cost in human life. If we had started earlier, with our unquestionably superior production know-how, our strength, added to that of the other nations of good intent, might have caused the Japanese to hesitate since they struck at precisely the period when Allied aircraft production began to exceed that of our enemies.

The problem of preventing future wars will not be solved easily. Even now, with the whole civilized world craving peace, grave issues arise among nations of good intent. It is our solemn duty to make a supreme and continuing effort to attain amity among nations. But we must not be blind to the realization that our best efforts may not be good enough at this stage of human progress.

The results of our efforts for world peace cannot be evaluated soundly now. It may take five or ten years, or even more, for these forces which cause wars to gain sufficient strength to test the quality of our labors toward the millennium. We must not relinquish our dominant air power until we are perfectly sure that it is safe to do so.

TO RETAIN our dominant air power we must develop a long term program based on a reaffirmation of sound fundamental policies, and we must execute that program regardless of inevitable pressures tending towards its impairment. But in the meantime there are four steps that can and should be taken immediately.

First, the Army and Navy should make plans for our permanent peacetime air force. Our military strategists, whose wisdom has been proven by our recent major victory, are best equipped to make the decisions as to the size and composition of our future air force and should be left free to do it. In approving these requirements, the Congress should bear in mind that the cost of dominant air power is *not* a drain on our resources but a contribution to our economic health through the employment it creates. A strong aircraft manufacturing industry will bolster both our physical and our economic security and cause future aggressors to think twice before they strike.

Second, we must not return to the cumbersome procurement policies in force before the war. The cost of aircraft prototype development has gone up tremendously and now no manufacturer can afford to gamble on a design on a win all-lose all basis. In prewar days the losers in design competitions frequently found refuge in an export market nourished by an international armaments race. This sanctuary may not exist, at least in the immediate postwar years. But the competitive relationship among manufacturers can and must be maintained by the encouragement of multiple sources for the same types of products. This principle has contributed much to the superiority of American aviation equipment.

AND THIRD, we cannot afford to assume that a possible future war will be like this one any more than this one was like the last. The weapons and materials used in the closing days of our war with Japan are those most likely to be used in some future surprise attack. And unless the Japanese surrender almost immediately, those weapons will be far more deadly than any the world has so far seen. Technological development must go on at a pace far more rapid than in any previous peacetime period. We must continue to fill in the blind spots in the aviation spectrum with new types of aircraft, new propulsion, and new sources of energy.

Last, but by no means least, we must find a realistic solution to the vital problem of surplus disposal lest we wreck our physical and our economic security in one fell swoop.

In the words of Air Chief Marshal Tedder, "We are witnessing all over the world the lopsided spectacle of phenomenal technological improvement occurring within thirty years of incredibly bad government." The truth of these words has come home to the thinking people of all nations many times in the past. In this country they represent a sharp challenge to our new Administration.

It is our most sincere hope that our new President will accept this challenge in the same spirit of fearlessness and understanding of his fellow men that he has demonstrated in his courageous career in Congress.

Leslie E. Neville

EDITOR

Carrier Aircraft Maintenance Is Really Tough

By **BLAINE STUBBLEFIELD,** *Washington Editor, 'Aviation'*

An AVIATION editor aboard one of Navy's newest flat-tops shows how crews overcome myriad complications of space, equipment, and weather to "keep 'em flying."

ABOARD 'U S S BONHOMME RICHARD', at sea—Aircraft maintenance on this heavy aircraft carrier, like that on all carriers, is aimed at keeping 100 percent of the planes available for use whenever needed, at maximum efficiency and with maximum safety. Rarely is the 100 percent availability achieved, but only in battle does it fall more than several percent below.

There is enough air force on a big U. S. Navy carrier, such as this one, to inflict great damage on an enemy task force, on a flotilla of merchant ships, or on a large city. The aircraft complement of this carrier is several scores. One officer says that if Napoleon had possessed just one such ship, with a trained crew, he could have conquered the world with ease.

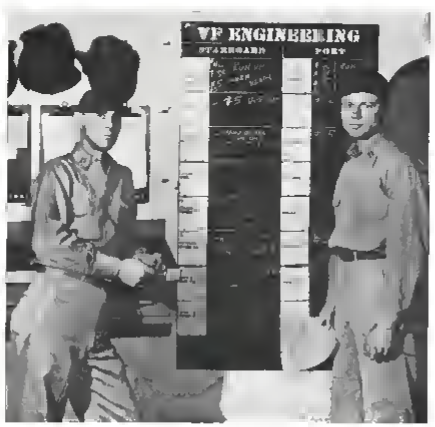
Maintenance of ship based warplanes gives longer life to the equipment, contributes to economy, and even adds to the smart appearance of the airplanes, for all surfaces are carefully polished every day. But these results are almost entirely incidental to the availability objective.

If there is a fuselage remaining of a damaged plane, the maintenance crew can make a new airplane of it, and do it quickly. This may sound like super maintenance with all the trimmings, but it isn't. The trick is replacement with assembled components.

Actually, it is what is called Class D maintenance—Class A being major overhaul work on both aircraft and engines; Class B, engines and accessories overhaul; and Class C, minor structural repairs and engine installation. Class D includes engine changes and installation of components. The first three classes, of course, are on-shore work. Maintenance officers say these classifications often are literally tossed overboard, but they do serve to give a general line of demarcation.

One component ready for installation as an example, would be a cowled and completely ready engine. Hydraulic, fuel, oil, electrical and other connections—surprisingly few of them all told—are labeled and ready to hand. Nearby and also ready for quick installation is a propeller, with plenty more propellers, wings, tail assemblies, landing gears, flaps, ailerons—everything except a fuselage—also available for quick fitting. And quite a lot of more-than-minor repair work can be done on a fuselage.

Because maintenance on the 'Bonhomme Richard's' airplanes is mostly installation work, her shop equipment might look pretty lean to a land-based man. Of course there are welding torches, metal brake bending gear, beading machines, grinders, drill presses and numerous hand and pneumatic tools. Aboard ship, at this writing, the men are proudly building a stand of their own for testing hydraulic gear. It is hoped that a field type instrument test stand soon can be acquired, since at present all faulty instruments must be removed and replaced.



Left: Much carrier-based maintenance work consists of quick change of complete units such as this completely cowled engine, seen ready for installation. Note propeller lashed to bulkhead in background out of way but easily accessible for speedy installation. Right: Directing maintenance of fighters, dive bombers, and torpedo bombers aboard 'U. S. S. Bonhomme Richard' are Lt. V. M. Lambert, planning officer (left), and Lt. William H. Zschoche, in charge of maintenance division. (All official U. S. Navy photos for "Aviation")

But even with their limited equipment, the crew can often take the kinks out of a sprung fuselage or a wing, weld odd broken parts, or bolt or rivet up something to carry the load safely till a new part can be had. Generally, however, no difficult repairs are made if there is a new part aboard, or a component that contains the essential part. Mainly the welding is done in minor structural repairs, and on some patching. There is no heat treating facility aboard, and no metal forming equipment. Only one component, the propeller, is assembled in the ship. Whenever a prop is taken out of stock, the crew assembles a replacement at its first opportunity.

Organization aboard a carrier is divided into two parts: The Ship's Company, which runs the ship, and the Air Department, headed by the Air Officer and his Assistant Air Officer, which has charge of the aircraft and their operation. The Air Department is in five subdivisions: V-1, Flight, V-2, Maintenance; V-3, Operations, radio, and radar; V-4, Administration; and V-5, Airgroup, the pilots, bombardiers and radio-gunners. V is Navy's symbol for heavier-than-air, Z is for lighter-than-air.

The moment a landing plane stops in the arresting gear, the pilot signals thumb up if it's okay, thumb down if he has a squawk. The latter gives the handling crew its cue to put the plane on one of the three elevators for the hangar deck. Usually all okay planes are spotted forward during landings; then they are spotted astern when all planes are aboard. Nearly all of the ship's complement of planes can be parked on the flight deck, in which case a number of those forward will be catapulted when the next flight begins. In certain situations, however, most or all of the planes are in the hangar deck but, as already indicated, a certain amount of maintenance is done on the flight deck when necessary.

As soon as pilots alight from thumbed-down planes they are asked by a maintenance officer for details of their squawks, and he sends the complaints to the Planning Desk, where work orders are written up for the crews concerned—regarding engine, landing gear, propeller, or whatever unit is affected.

Ingenuity of American maintenance men is not limited by shore line. Here is hydraulic test stand built aboard ship of bits and pieces by maintenance crew of 'Bonhomme Richard,' one of Navy's newest carriers.

Because an airplane may have one or several defects unknown to the pilot, each plane, however, reported by the pilot, is examined by an inspector, who may make out an additional complaint which results in another work order.

Wherever there is work there is paper work, and this floating maintenance is no exception. Maintenance officers have offices, with desks and filing cabinets, but very few typewriters are in sight. In the files is a "flight jacket" or folder which shows what has been done to every plane on the ship, and when. In addition, there are logbooks for each airplane, each engine, and each propeller. And there are consolidated time charts on the engines and planes. These charts show at a glance the time flown since the last check, and when the next check is due. They serve also to show up "high time" engines and planes which need attention before a strike is made.

Some things that happen to deck-based airplanes are completely foreign to landsmen. For instance, when planes are packed together like sardines, there inevitably are an abnormal lot of hangar crashes. And when so many planes are operating on an airport no bigger than three or four tennis courts—an airport which is moving in three dimensions—plus the factor of very young pilots, plus continuous high winds, plus severe eddies around the runway, there are bound to be landing and takeoff accidents.

In routine operations these don't happen every day, but often enough. This ship has been lucky; it has completed a long shakedown, and is now six days out of port, and not a man has been killed or hurt. In combat, some airplanes come back shot up, sometimes with wounded crewmen aboard, and there are more than routine landing accidents. It is no secret that when a plane is in such shape as to jam traffic at a critical time it is thrown overboard at once.

With aircraft taking the beatings not only inherent to a tiny, pitching, windy "airport" but from combat as well, maintenance becomes of prime importance. Too, the designs necessary for carrier operation add equipment which must be kept in top shape. Extra hydraulic equipment is necessary, for example, on the wing-folding units on the Grumman TBF Avengers, Curtiss SB2C Helldivers, and the Vought F4U Corsair, some of which the "Bonhomme Richard" carries for special missions.

This carrier's maintenance crews are constantly alerted to hardening of packing, loose fittings, and hose connections to prevent hydraulic fluid leakage throughout the systems, including landing gear and wing flaps. In some cases, leakage has persisted as long as a month, until the airplane is well shaken down.

Gyro instruments, too, require constant attention due largely to the fact that new pilots often forget to cage them prior to maneuvers. Officers in charge report that new model instruments will help solve that problem, but meanwhile many instruments must be quickly removed and replaced by new or re-conditioned units.

In normal carrier landings the planes are dropped some 15 to 20 ft. in stalled condition. This is done not only to lower speeds at which the arrestor cables are engaged, but to assure sufficient height while passing over the carrier fantail in case the stern rises on a swell at the time of approach. Naturally, such landings increase the number of tire blowouts, calling for speedy changes and replacements. However, blowouts do not appear to be unduly frequent, the writer has seen all this carrier's aircraft take off and land several times without a single such occurrence.

Propeller accidents are fairly frequent, due simply to crowding of planes on the decks, to deck crashes, nose overs, and cartwheels. Rare but interesting is propeller damage by hitting cartridges and belt linkage discharged from the guns of airplanes flying ahead. Too, there are the usual encounters with unwary birds.

How the ship's men avoid being sliced up by propellers of planes standing nose-to-tail and wing-to-wing is a mystery to this observer, even though signs everywhere, and the

sound amplifier, give constant warning. Fortunately, however, injuries and fatalities are surprisingly few.

Salt water at sea is the bane of maintenance men. It flies through and all over the ship in wind and spray. In storms it comes aboard in green swells. It constantly eats into most metals and other materials. It roughs up skin surfaces, sometimes setting up 10 mph of additional drag if not removed.

The best remover of salt is fresh water, but unfortunately the ship's evaporators, though huge, have trouble enough producing sweet water for boiler feed, drinking, laundry, cooking and two or three thousand shower baths every day. Such is the proficiency of the "Bonhomme Richard's" water engineers, however, that they merely complain about tap hogs. Men can stand in the shower to their heart's content (if they have time) and no gestapo will stop them. So there's little water for washing planes. All the known anti-corrosives are used in the building of Navy planes, and every accessible part is kept rubbed down and filmed with resistant oil, but still the sea's chemistry works at enormous cost.

Biggest seagoing handicap against airplane maintenance, though, is lack of space. As space-economizing wing folds are improved, the saving goes to more planes, not to more room. This carrier is as long as three football fields end-to-end, and has a beam of over 80 ft., but there are between two and three thousand men aboard and they are always in each other's way. Each one of the 243 maintenance men has to step around or under or over another man at almost every move.

As already indicated, the airplanes are packed in—like the gadgets in a parachute kit. Every time one moves more than a few steps it is necessary to crawl under a wing or a belly. If a nearby propeller isn't running, that's lucky. If a work stand has to be moved, it must be collapsed and pushed under or around. Many of the wings, tail pieces, propellers and other components, are suspended overhead or placed on bulkheads, and many tools and parts are available at the top of a long ladder.

But considering limitations, the arrangement and economy of space is admirable and practical. The workshop and much of the parts storage occupies the extreme aft section of the hangar deck and what might be called a mezzanine deck. Clearance in the hangar deck is actually three decks of elevation, to accommodate propeller height.

Next to space limitation in nuisance value probably is the motion of the ship. This takes the form of roll and pitch, which seldom stop entirely, and vibration caused by the four gigantic engines and propellers which, of course, never stop except in port. When these are augmented by the disturbance from 2,000-hp. airplane engines and the ship's guns and catapults, the total rumpus is, to put it mildly, very disconcerting. The motion diminishes hand dexterity, especially on small manipulations, and the turmoil uses up the men's energy.

Very seldom if ever is the entire ship's complement of airplanes on either the hangar deck or the flight deck, which further complicates maintenance. The lower deck is of course well protected from the wind, is well lighted, comfortably warmed in cold weather, and well ventilated. But the upper deck, where some maintenance work must be done, is nearly always too windy for comfort. The ship's cruising speed of 15 to 25 knots creates quite a breeze, and when she opens up to top speed, and heads into any sort of gale, it takes effort even to stand up, let alone work in the wind. In fact, the limitation on human ability to work in wind is the limitaton on flyability of the deck—the airplanes can take more wind than can the crews. The new high-lift planes of this war show little tendency to blow over, but of course on shipboard they are all lashed down.

All work possible is done on the hangar deck because of the obvious advantages, among which should be mentioned the excellent hoisting equipment, electrical, oil, air, and other services.

Work hours are any hours when there's flying; other times the crews aim at an 8-hr. day. There is very little grumbling, no slacking. The boys are mostly from schools, farms, drug stores, few consider ideas about the rights of labor. Most of them are patriotic, and most are sentimental about their ship and their airplanes. Their officers wear work clothes, stay on the job, require no military formality, and give no sign of compulsion.

Each man on a Navy ship has several jobs. Maintenance men get "pulled off" their airplanes to man battle stations, to break out provisions or, like other crewmen, to do any essential job.

The life of a maintenance man—or anyone else—aboard a carrier is not easy. Like shore-bound maintenance, much of the work must be done in the dead hours of the night, after flying has stopped. And it must be done under all the difficulties imposed by the very nature of carrier operations. But the boys from the schools, the farms, and the drug stores really do the job.

Working in very cramped quarters—either on flight deck or on hangar deck as shown here—is routine for carrier aircraft maintenance crews. Additional complications are brought about by pitch and roll of ship and vibration caused by powerful propulsive machinery.

Australian Boom Hinges on Private Enterprise

Australian postwar plans envisage early inauguration of London-Sydney route by Qantas Empire Airways and British Overseas using Avro Yorks similar to this craft, specially built for Duke of Gloucester in connection with his duties as Governor General. Aircrews—including 60 pilots, 20 avigators, and 20 radio operators—are already in training for transport operations. (British Combine photo)

By H. BOWDEN FLETCHER, DFC

Vast expansion in transport network and maintenance of production capacity is seen if government monopoly can be avoided in the "down under" continent.

DESPITE A SERIOUS THREAT of nationalization, Australian airline operators are planning well ahead for postwar expansion, basing their programs partially on prospects of receiving at least part of their equipment from Australian aircraft factories.

It is generally felt in the industry that, if government monopoly can be avoided, a boom in civil air transportation is assured, for at least five major groups, four of which envisage use of American aircraft, are taking steps looking toward airline expansion.

Prominent among them is Qantas Empire Airways which, in conjunction with British Overseas Airways, has announced a plan for daily service—to commence almost immediately—over a route from London to Sydney via Perth, in Western Australia. BOAC would fly the London-Ceylon portion, Qantas from Ceylon to Sydney.

According to present plans, the service would be inaugurated with Yorks, transport version of the Avro Lancaster bomber, and 60 pilots, 20 avigators, and 20 wireless operators have already been selected for an intensive course on the civil transport angle. Most of these men have been selected from the Royal Australian Air Force and have had operational experience.

The proposed schedule calls for a 60-hr. journey which would, of course, lower the prewar time taken by the same companies over their flying-boat route via Singapore. It will, of course, link with the Sydney-New Zealand service currently operated by Tasman Airways in which Qantas, BOAC, and the New Zealand government each have a third interest.

Ansett Airways plans a 30-hr. Australia-America service, using Lockheed Constellations. This proposed service is based on the craft having a 270-mph. cruising speed over a 4,000-mi. range, and it would provide sleeper accommodations for 24 passengers.

Plan 270-Town Pickup

This same company has an ambitious scheme for an airmail pickup service between Melbourne and 270 towns in Victoria. The idea is to deliver the mail by parachutes of the type at present used in military service to drop supplies from low altitudes, and to pick it up in much the same way that messages are now picked up by military craft. Distribution of morning and evening metropolitan newspapers is a part of this plan, and other cargo undoubtedly is under consideration.

Australian National Airways has placed an order for between £2,000,000 and £3,000,000, Australian (approximately $6,480,000 to $9,720,000) worth of Douglas planes for delivery as soon as war conditions permit. The company has not announced any definite plans, but it is expected to increase the frequency of present services which stretch from Perth to Cairus, in Queensland. It is also understood to be considering overseas services, including an extension to New Guinea.

Australian National has also made an offer to purchase Guinea Airways, a proposal submitted by directors to the latter company's shareholders, with recommendation that it be accepted. Under the plan, Guinea Airways would receive 275,000 preference shares of a par value of £1 Australian, bearing a fixed dividend rate of 6 percent, without further participation in profits.

Certain Guinea Airways shareholders

(*Turn to page 259*)

How to Estimate Costs In Feeder Airline Operations

PART III OF A SERIES

By **JAMES G. RAY,** *Vice-President, Southwest Airways Co.*

Detailed here is a sound procedure for measuring direct and indirect feeder expenses, together with a method for balancing them against potential income as a means of predetermining profitability of proposed operations.

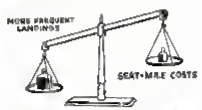
VOLUME OF AIR TRAFFIC from the smaller cities and towns should be considerable—and feeder airline operating methods can be developed that will furnish a service having substantial advantages over other forms of transportation. These two prime points were demonstrated in our two previous articles, and it is now in order to look at the probable costs of feeder operation.

To date there has been no actual operation of a true feeder airline carrying all three types of traffic—passengers, mail, and cargo. Without specific operating data, the discussions of costs necessarily will be somewhat general; we will have to say what they should be instead of what they actually are. Many assumptions must be made, including the one that the method of operating will be as already outlined (all previous articles).

This method calls for carrying passengers, mail, and property by making regular landings at points of service when passengers are to be taken on or let off and by making mail and express pickups at all other points of service. The most suitable type of aircraft was

described as a high-wing twin-engine plane carrying 12 to 15 passengers and 600–1,000 lb. of mail and cargo. It should have a tricycle landing gear and flying characteristics that would permit its operation out of sea level airports having 2,500-ft. runways. Various operating procedures were recommended that would decrease landing time losses and thus permit faster scheduling.

If we compare the cost of feeder operation to known items of trunk airline operation, we find that certain



things are more expensive while others are less. Best examples of lower cost are found in the items that make up passenger service. In general, passengers riding the short distances on feeder routes will not require the same conveniences and comforts as are provided on trunkline planes. The traveling public has been taught to expect this by the railroads, which furnish much less service to off-mainline towns.

Among services that can be dispensed with are hostesses and meals aloft. Passenger seats need not be luxurious, which will save weight. Also, they can be put closer together in the cabin and the aisle can be narrower, which will save space. Possibly, less sound proofing will be needed. Passengers can be expected to look after their own luggage to some extent, and if convenient loading steps are provided, they can go aboard or deplane without assistance. Somewhat less service will be required in the booking of passengers; also less in the way of waiting rooms and other passenger handling facilities and personnel. All of these things tend to lower operating costs.

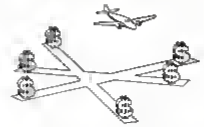
Cost items that will increase are principally those affected by the greater frequency of landings. It is obvious that aircraft which make frequent landings will be subject to extra wear and consequently to higher maintenance. Extra gasoline will be used in getting back to cruising altitude and speed. Though the operating method assumed earlier calls for an on-course operation whenever possible, inevitably some mileage will be lost in circuitous flight in maneuvering for landings. Frequent landings will slow up the schedules which, in turn, will increase the per-mile costs because depreciation and other fixed items of overhead must be absorbed by fewer total flight-miles.

Certain costs, such as pilots' salaries, etc., are approximately the same for large or small aircraft. When these costs must be absorbed by a smaller number of passenger seats, the cost per seat-mile is necessarily higher. But larger aircraft usually cannot be used in feeder operation because, as pointed out in the previous articles, schedules must be flown more frequently. Passengers will not wait long for a schedule if the journey is short.

The volume of traffic usually will not be great enough to give high load factors if large aircraft are used. Smaller aircraft running at a high load factor will cost less per seat-mile than

larger aircraft carrying more empty seats. Thus, the aircraft's size is set at say, 12 to 15 passengers as the best compromise between the better economy of large aircraft and the necessity for frequent scheduling. An aircraft of this size embodying the latest technical and engineering advancements that have been made during the war, should operate at a seat-mile cost as low as the prewar Douglas DC-3.

Another cost item that may increase is the charge covering landing fees and passenger facilities due to the larger number of airports involved.



However, the cost per airport should be considerably less because the airports are smaller. If the average charge per airport is reasonable, the per-mile costs should not increase in view of the frequent schedules.

In this connection it can be expected that the towns will make reasonable charges for the use of their airports in the beginning of feeder operation. The service will be valuable to them, hence they should help get it established. But for some time to come the feeder airline cannot pay the full carrying charges of all the airports it will need to use. Some means should be provided for determining uniform landing charges; it may be necessary to discontinue service to a town if its charges are exorbitant.

The easy way to estimate the cost of an airline operation is to take the direct flight costs for the type of aircraft to be used and increase them by an arbitrary percentage deemed sufficient to cover all other expenses connected with the operation. Unfortunately, this method may be unreliable for feeder airlines because there has not been enough actual practice to determine the correct percentage to use.

For a given system of feeder routes, fairly accurate cost projections can be made by taking each item of expense and carefully analyzing it. For instance, each point of service can be analyzed as to facilities and personnel that will be required, basing the calculation on the amount of traffic expected from that town. When these are known, it is easy to figure their costs.

As an example, Town D on the sample route given in last month's article would generate 4.6 passengers per day. Five round trip schedules and 3.4 landings were projected to give this service. The station could be operated by one man, at a time; he would be both ticket agent and operations man. His pay would run about $140 per month. And because the station would need to be open longer than 8 hr. per day, two men would be needed.

If we assume the airport charges plus passenger facilities to be $100 per month and communications and incidental costs to be another $50, the total is $430 per month. Some additional expense for transporting mail and express between town and airport must be allowed for, over and above the revenue from carrying passengers on the same trips. But this would not bring the total above $500.

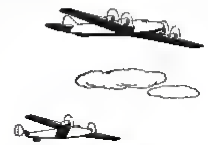
Town H of the sample route is smaller than D and has 3.1 passengers and 3 schedules. Service to it could be limited to the 8 hr. of a single shift, thus requiring only one man. The total cost of the station would be about $300 per month. Station E, with its 18 passengers per day and its five round trip schedules, would require at least three men. The cost of this station probably would run about $750 per month.

Likewise, the various departments of the operating organization can be analyzed. From the number of aircraft and the hours of flying per month, the man-hours of maintenance can be calculated. Similarly, the personnel requirements of the traffic department, of communications, and the other departments, can be determined. The materials needed by the various departments can be estimated, except where a new type aircraft is being placed in operation for the first time. If there is no actual maintenance data based on operating experience, it may be quite difficult to estimate the cost of materials for maintenance.

For the purpose of this article, it is obviously a matter too complicated to make all the necessary assumptions on which to project a complete set of costs for a hypothetical feeder airline operation. The assumptions would be too difficult to follow and probably would not apply exactly to any feeder system. But, to establish the method of estimating expenses, certain of the major cost items can be analyzed and compared percentage-wise with corresponding trunkline costs.

Pilot costs on the trunklines run about 8c. per revenue mile or about 13 percent of the total operating costs. If feeder airline pilots are paid according to the ruling of the National Labor Relations Board, which presently determines trunkline pilots' pay, the cost would be 8.7 c. per mile for both pilot and co-pilot, assuming an operating speed of 150 mph and that the pilots fly 75 hr per month, 20 of which would be at night. This item would be about 18 percent of the total operating cost.

However, it seems probable that pilots' pay will be scaled down somewhat for feeder airline pilots. The present wage scale was set for trunkline pilots, flying DC-3 equipment. Recently, the pay of pilots flying TWA's Boeing Stratoliners was increased some $80 per month, because they are flying larger airplanes. This same line of reasoning would indicate that feeder airline pilots, flying smaller aircraft, may be paid less than the present NLRB ruling.



The cost of gasoline, insurance, etc., would be proportionately about the same as in trunkline operation and would bring the total direct flying costs to about 15c. per mile. Flight equipment maintenance and depreciation would run another 10c., totaling 25c. per mile as the direct aircraft operating cost.

In 1940, the last prewar year, this figure was 30.57c. for the trunklines. The difference seems to be easily accounted for by the difference in size and cost of the flight equipment. Also, a larger percentage of feeder airline flying will be in daytime, for which the pilots' pay is less.

Three of the eight items making up ground and indirect cost are apt to differ from corresponding costs in trunkline operations. These are ground operations, traffic and sales, and passenger service.

Ground operations may need a larger number of employees because of the larger number of points of service. On the other hand, many of these employees can work part time for ground operations and part time for traffic and sales, so that the over-all cost of personnel for both departments may not be greater than in trunkline operation, where separate staffs are used for each department. Passenger service is certain to run considerably less because no hostesses or food service will be needed.

If the sample route considered in last month's article were operated as a part of a feeder airline system made up of other similar routes, and if sufficient route miles were included to permit realization of the economies of size, the total operating costs should closely follow the breakdown shown in Table I at bottom of next page.

In last month's article, the probable revenue from passengers on the sample route was shown to be about 40c. per mile. The remaining 9c. per mile to equal the total cost of 49c., as shown in Table I, would have to be paid for by revenue from mail and express.

In the first article of this series, it was shown that probable volume of mail generated daily would be about 5 lb. per 1,000 population. The sample route, with a population of some 120,000, thus would generate about 600 lb. of mail per day. The cost ascertainment reports of the Post Office Department show that the average revenue per pound for airmail at the old 6c. per ounce rate is $1.78697. The figure for the new 8c. rate is not available and should not be used in any case, since it is expected that this rate, which was a wartime revenue measure, will be repealed when hostilities are over. Thus, 600 lb. at $1.78697 is $1,072, which represents the total revenue to the Post Office Department from the airmail generated by the sample route.

As was shown in the first article, the express poundage would run about 60 percent of the airmail which, for the sample route, would be about 360 lb. daily. The express revenue of All America's feeder operation for the year 1943 was 6.54c. per pound, and 360 lb. at 6.54c. is $23.50 or 2.7c. per revenue mile. Thus we have 40c. per mile revenue from passengers, plus 2.7c. from express or a total of 42.7c., leaving 6.3c. of the 49c. per mile operating cost to be paid by airmail.

The 852 miles shown as the daily scheduled mileage on the sample route times 6.3c. is $53.68 per day, which is the amount of mail pay needed out of the $1,072 gross revenue accruing to the Post Office Department for the operation to break even.

Of course, nothing like all of the $1,072 would be available as pay to the feeder airline operator without incurring subsidy. Much of the mail, probably at least two-thirds of it, will have to be handled by other air carriers before it reaches its final destination. Also, it will require ground handling at its points of origin and destination.

So far, we have considered only the actual operating costs, and of course, the operating company will need to make a profit. This will add another 2c. or 3c. per mile to the 49c. of actual operating costs. But a figure of approximately $1,000 per day will still be available to take care of all the remaining expenses in connection with handling the mail, and to pay the Post Office Department a substantial profit.

Thus, if the above assumptions and estimates are anywhere near correct, feeder airlines would prove to be profitable to the government. In fact, the assumptions would have to be a long way from correct before the government would be put to any great expense. Compared to actual trunk line operating costs, they are not out of line. Eastern Airlines, using Douglas DC-3 equipment, operated for 52.98c. per mile in 1940, only 3.98c. higher than the figure arrived at here. Continental, Inland, and National, all using aircraft smaller than the DC-3 but larger than the proposed feeder plane, operated at costs of 42.78c., 42.53c., and 40.78c., respectively—all well below the cost figures projected above.

These comparisons with the actual cost figures of trunkline carriers indicate that the figures projected above are in line. The traffic projections used here are equally conservative and are based on actual records of trunkline traffic generation as taken from the CAB surveys for 1940.

There seems to be little possibility that feeder airlines would prove to be expensive ventures for the government, if proper routes are laid out with due regard to their traffic generating possibilities and are operated correctly in units large enough to provide sufficient size for good operating economy. If these fundamental concepts are not followed, however, they can become wasteful of public funds.

There are many good and sound reasons why feeder airlines should be established now. They can provide overnight airmail from practically every town in the country to every other town. Passenger service can be furnished most of our cities and towns having a population of more than 4,000 or 5,000. Nearly an additional third of our national population can be given direct air service.

By their extensive use of aircraft and aviation products and accessories, considerable economic support can be given to our aviation industry—a support that must be provided in some form because of aviation's importance to our national defense. Additional employment of highly trained aviation personnel—also essential to our national defense—would be provided at a time when such re-employment will be important to our national reconversion program.

The argument most generally advanced against the expansion of our air transportation system to include direct service to a large number of smaller cities and towns is that feeder airlines will need excessive governmental expenditures for their support. This line of attack is being made by trunklines in the CAB hearings now being held on feeder applications in various parts of the country. Subsidy, they say, is a very vicious and unsavory thing.

This is an odd position for the trunklines to take, for they owe their very existence to the subsidy paid them for many years. A number of the smaller trunklines are still receiving it, and all are paid more per pound for carrying mail than they receive for carrying passengers or other cargo.

Fortunately, feeder airlines should not be nearly as expensive in their beginning as were the trunklines. The reasons are not difficult to understand. Technical knowledge is now available to build special aircraft that will be efficient vehicles of transport for feeder airlines. Operating procedures have been developed to greatly increase the efficiency of the service which can be rendered, moreover the public has been educated to the safety and value of air transportation.

None of these advantageous factors marked the beginning of trunkline operation, hence a long period of substantial government assistance was to be expected. Accordingly, the present situation is not analogous—the necessary technical knowledge is available and the public has accepted air travel.

One of the best investments this country ever made was to spend federal funds during the 1920's and 1930's to establish and support a trunk airline system. This investment has paid for itself many times over. And this swift and efficient transport service has been of inestimable value to the war effort. The operating know-how and trained personnel from the trunklines have formed the nucleus of the Army and Naval air transport services.

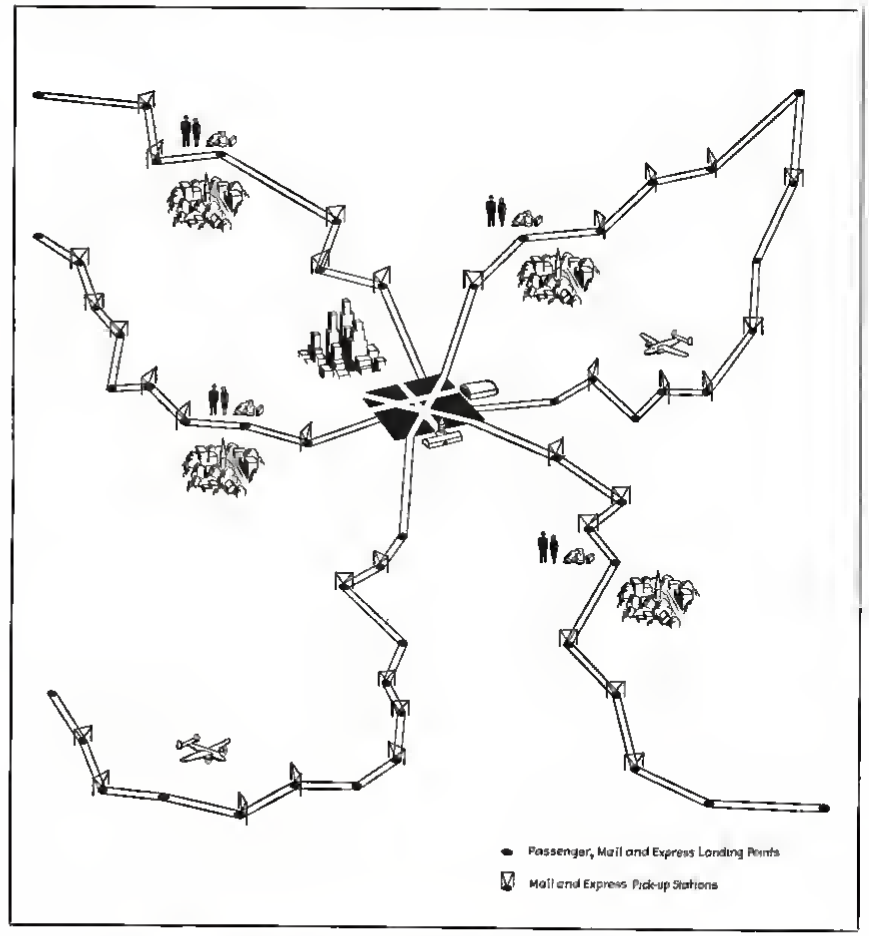
Pity is that our airline system was not larger at the beginning of the war. We sorely needed many times what we actually had. If we had invested twice or three times as much money in building up a larger airline system before the war, it would perhaps have saved us billions of dollars in war costs.

Added to this is the fact that profits from airmail in the last few years have repaid the government all the subsidy expenditures ever made to the airlines. In other words, we have gained these tremendous benefits from this great national asset and, in addition, have already got our purchase price back.

Completion of our air transport system by extending direct air service to an additional one-third of our population should further enhance the value of this national asset. Buying a national system of feeder airlines should cost very much less than did the trunk airline system—indeed there is much evidence that it might not require any subsidy at all.

Table I—Comparison of Feederline and Trunkline Operating Costs

Department	Feederlines Cents Per Rev. Mi.	Feederlines % of Total Costs	Trunklines, 1940 Cents Per Rev. Mi.	Trunklines, 1940 % of Total Costs
Flying operations	15.	30.6	15.20	31.5
Flight equipment maintenance, direct	5.5	11.2	4.81	10.7
Depreciation, flight equipment	4.5	9.2	4.86	7.6
Sub total	25	51.0	30.87	30.7
Ground operations	11	22.4	11.06	15.1
Ground equipment maintenance, direct	1.	2.0	0.73	1.2
Equipment maintenance, indirect	1.	2.0	2.43	4.0
Passenger service	1.5	3.0	3.00	4.5
Traffic and sales	4	8.2	4.97	8.1
Advertising and publicity	2	4.1	2.78	4.5
General and administrative	3	5.1	4.43	7.6
Depreciation, ground equipment	.5	1.0	0.84	1.4
Sub total	24.	49.0	30.44	49.3
Total operating cost	49	100	61.01	100.00



Typical layout of feederline operation, showing how a trade area could be covered by combination of passenger, mail, and cargo landing points and mail-cargo pickup stations, with all routes feeding traffic into center of trade area and radiating out from it.

MARKETING

NOVEL PRESENTATION PROMOTES FLIGHT COURSES

Faced with the problem of making sales among several classes of flight prospects in a single campaign, Wiggins Airways devised this unusual—and highly effective—piece of advertising.

NOWADAYS, when nearly everyone interested in aviation has acquired a smattering of the knowledge and the nomenclature, the selling of flight courses runs the risk of becoming involved by discussions on almost any phase of flying but that of instruction.

This situation is in no way bettered by the fact that there are a number of different types of prospective flight students, each of whom has to be approached in a slightly different manner. High school boys, discharged GI's wishing to qualify for commercial work, aircraft mechanics, women of all ages, those who already hold a private pilot's license, and several other classes, all are good material for the flight school. Yet few of them have either the same needs or viewpoints. In order to sell to as many different classes as possible in a single mail campaign, Wiggins Airways of Norwood, Mass., planned the special booklet illustrated in this article. Illustrated by Cartoonist Dahl, of a leading Boston daily, and written in conversational style, this 16-page book has had remarkable success. In fact, Wiggins states it has been swamped by demands for it, including calls from other operators in all parts of the country. To accommodate these requests, the company has prepared proof sheets of both the cartoons and text, making a nominal charge to cover the artist's royalty.

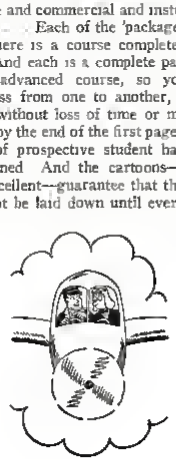
Most remarkable instance of the popularity of this booklet is the fact that two agencies for competing makes of lightplane in the same city are both using this sales method with good results.

Beginning with a cartoon of a puzzled man shaking a package, with the

caption reading, "What's In It?", the first page starts out—

"Maybe you want to be an airplane pilot and maybe you don't. . . . Perhaps you want to find out what flying is all about. . . . Possibly you'd like to do a little flying, just to know how it feels to juggle the controls. . . . Maybe you want to solo. . . . As for you who have ambitions to become private and commercial and instrument pilots. . . . Each of the 'packages' outlined here is a course complete in itself. And each is a complete part of a more advanced course, so you can progress from one to another, if you wish, without loss of time or money."

So, by the end of the first page, every class of prospective student has been mentioned. And the cartoons—which are excellent—guarantee that the book will not be laid down until every page



has been turned. Meantime, the reader has his eye out for the particular "package" containing the instruction which interests him.

Package No. 1 is labeled $6 and its contents are described as five evenings of lectures which work you "up to the point where you can discourse learnedly on Navigation (how to get there and back without going on a Cook's tour), meteorology (the weather and what to do about it), Civil Air Regulations (how Uncle Sam polices the air space), general servicing of aircraft (what to do when you're miles from a mechanic). . . . There's no flying in this package, but you can go right on from here if you decide to."

Second package, priced $30, includes the first one and also offers four instruction flights. "You're not a pilot when you've finished the contents of this package, but you are a flyer," says the text. "So now you can talk like a flyer and act like a flyer. Of course, if you want to get a license, there's no reason why you shouldn't go on from here." Here, the cartoon opposite the text depicts a two-place plane in which the student is accompanied by an instructor.

Then, on the next page, the same plane and student is shown—but minus the instructor. The student now sports a wide grin of confidence, due to having absorbed the $98 contents of Package No. 3, the solo flight course. "Uncle Sam won't let you carry passengers yet," says the caption, "but you can scoot around on aerial jaunts by yourself, without an instructor to jog you. (And if you keep going you might get really good. Take a look at the next page)."

On the next page the same student appears with the girl friend in the seat formerly occupied by the instructor. "You've really got places when you've digested the contents of this package," which costs $380 and is the private license course. "Uncle Sam says you're ready to carry passengers from here to anywhere (weather permitting). . . . You can rent a seaplane now and take your friends fishing at some remote lake. Some people say you're only beginning to fly when you

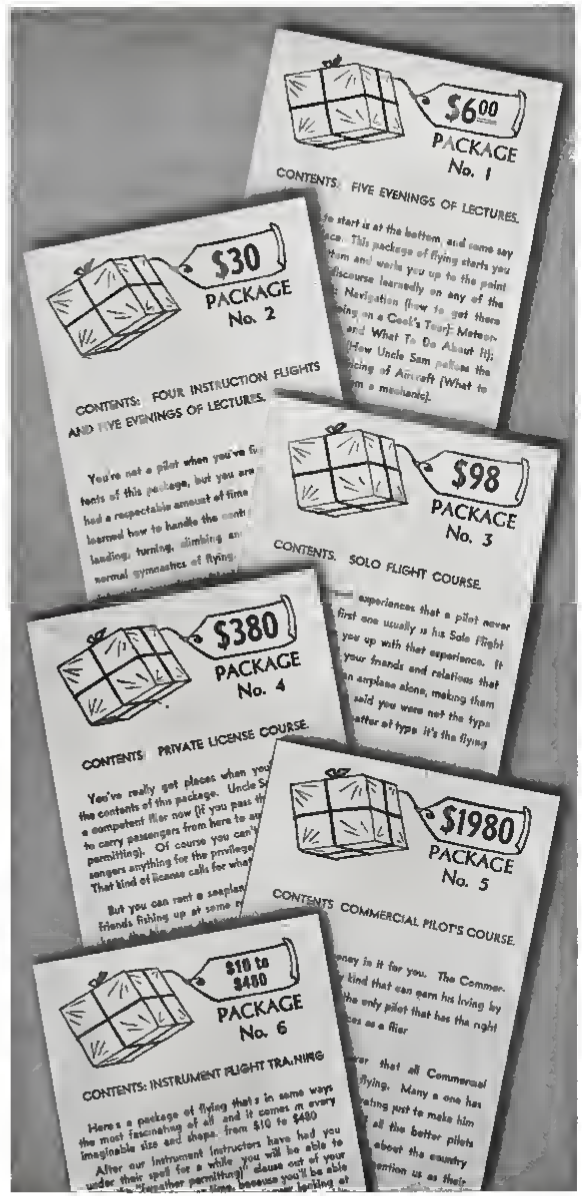
get your private license, but of course those people are commercial pilots and have a lot of 'hours' to their credit. The only satisfactory way to answer them is to become a commercial pilot yourself so you can talk on their level. . . . Turn the page."

By this time the man who still reads has begun to imagine all the things he would be able to do "if." So he turns the page and finds a picture of the same flyer—a student no longer—wearing an airline uniform and piloting a crowded airliner. "Now there's money in it for you," reads the caption concerning the commercial pilot's course, i.e., $1980 priced Package No. 5. If you're interested in a commercial course better drop around and talk it over. You're getting into flying in a big way now—too big for one page of this booklet."

Now almost convinced that he, too, can be an airline pilot, the reader again turns the page and finds Package No. 6, covering instrument flight training, with cost varying from $10 for an hour in a Link trainer to $480 for the CAA instrument rating course. "After you get your instrument rating, it's legal for you to fly into a cloud and see what's in the middle. Other pilots can't do that." And thereupon the booklet closes, with a short advertisement appended telling the prospect where to apply.

Fred S. Tobey, formerly publisher of *Yankee Pilot* and now in charge of publicity for Wiggins Airways, particularly notes that students pay "by the package" under this system, rather than on an hourly basis, as formerly was customary. Mr. Tobey also states that the solo flight package—No. 3—at $98 has proved the most popular and has developed numerous students to order Package No. 4, leading to the private license.

Since the courses are arranged on a progressive basis, each covering the subject matter of those before it, the student is not out of pocket when transferring from one course to the next.



Starting with $6 package of five lectures, descriptions of various bundles demonstrate to reader how he can progress from stage to stage in flight instruction without duplication of what has already been covered.

FINANCE

Analysis of banking group study shows domestic and international route growth will require $750,000,000 new funds for flying and ground equipment, bringing additional items to balance sheets. Hence experts—

Forecast New Type Loans For Transport Expansion

By **RAYMOND L. HOADLEY,** *Financial Editor, "Aviation"*

THE HUGE financing programs faced by the airlines in the next 5 yr. augur almost as startling a picture of industrial growth for one of America's newer industries as has the war production record of the aircraft manufacturers.

Our domestic airlines will need $500,000,000 in additional funds for expansion in the next half decade, while U. S. flag operators flying the international routes will require $250,000,000—a grand total of $750,000,000 to finance American commercial airlines by 1950.

These are the same airlines which have never had as much as $10,000,000 outstanding in debt and which today value all their property at little more than $50,000,000, having a net worth of about $100,000,000 and a combined working capital of $85,000,000.

These amazing figures on airline finance are not just pulled out of the air. They are the result of the most comprehensive study on airline expansion and financial requirements ever made. They were compiled by three big New York banks—Bankers Trust Co., Chase National Bank and the New York Trust Co., along with the Mutual Life Insurance Co.—after months of study, consultation, and survey by financial men of the group, together with prominent technicians of both airplane manufacturers and transport companies. Public officials also were consulted.

First, this research group went into the matter of traffic potential and found it reasonable to expect that the domestic airlines will fly some 8,000,000,000 passenger-miles by 1950, compared with a little over 2,000,000,000 last year and approximately 1,600,000,000 in 1943. At the same time gross operating revenues will jump from around $150,000,000 in 1944 to $500,000,000 in 1950. For the first few years after 1950, traffic is expected to increase at a rate of 15 percent annually.

In order to carry the traffic projected for 1950 the domestic airlines will need equipment with approximately five times the seating capacity of their present fleets. Since many of the planes used will be of greater capacity than those now operated, the number of airplanes will be three times larger than those now in service, or nearly 1,000.

This means that the domestic lines can budget around $300,000,000 for flying equipment and spare parts in the next 5 yr. and another $100,000,000 in such facilities as hangars, maintenance equipment, communications, and office equipment. Furthermore, the experts say, these lines will need another $100,000,000 in additional working capital to take care of this huge expansion in plant and equipment.

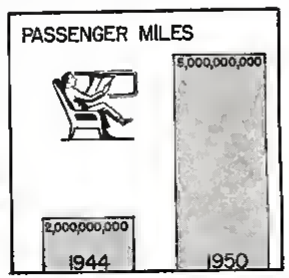
Thus the domestic lines are figured to need in the neighborhood of $500,000,000 by 1950. This estimate includes a reasonable allowance for creation and expansion of feeder lines as well as for anticipated development of cargo and express business. Also influencing the estimate is the probability that domestic first-class mail will travel by air whenever expedient.

Regarding the line to fly international routes it is obviously much more difficult to make projections. However, the figure of $250,000,000 is set down as the approximate amount that the lines operating abroad will have to spend by 1950. More than one-half of this amount, it is estimated, will be for flying equipment, the cost of which necessarily will be higher than for types used in domestic operation.

How will this combined total of $750,000,000 be financed? According to the study it will be provided in about the following manner:

Retained profits	$80,000,000
Depreciation	170,000,000
Sale of stock	150,000,000
Creation of debt	350,000,000
Total	$750,000,000

Creation of $350,000,000 in debt (even though the maximum outstanding at any one time should be well under this figure because of regular amortization and its creation over a 5-yr. period) obviously represents a radical departure for the airlines. As previously stated, their debt commitments up to now have been under $10,000,000.



Well managed lines, however, should be able to borrow a substantial portion of the cost of their flying equipment. The huge size of such potential borrowings indicates that most loans will be secured. While there has been much discussion in recent years of the probable use of the railroad equipment trust type of loan, no such standardized type of borrowing instrument is likely to be adopted in the near future.

The chattel mortgage, conditional sale contract and equipment trust appear to be the most likely mediums for airline financing in the next few years. Certain changes in legislation are believed desirable by the bankers, and the type of loan used will be influenced by the legislation that is passed. But it appears that the chattel mortgage will be most frequently used in domestic operation while the equipment trust or conditional sale contract may be used for airlines operating abroad.

Chattel mortgages are open to airlines, as they have not been to railroads, because airlines do not have general mortgages containing after-acquired property clauses. Under a railroad's general mortgage, when equipment was purchased it fell into the "maw" of the mortgage and so first liens by way of chattel mortgages could not be given on new equipment.

When equipment is operated abroad, the chattel mortgage is the least desirable form of debt since the concept of the chattel mortgage has little legal recognition outside the United States. But for domestic operations it appears to be the simplest and most flexible, and therefore the most desirable—at least in the opinion of the bankers. They point out that later purchases of equipment can be more easily financed by further securities issued under the original chattel mortgage because of the general familiarity with these mortgages.

The reason equipment trusts are favored by the bankers for use by international airlines is that in case of seizure abroad the airplane, under the equipment trust, stands in the name of the lender rather than in that of the operator. It has the disadvantage, however, of being a far more complicated type of instrument.

The conditional sale contract stands in an intermediate position between equipment trusts and chattel mortgages. Unlike the equipment trust holder, the lender has only a bare security title, does not claim to be the general owner of the equipment, and has no lease.

Before any financial institution grants a large loan to an airline for a period of several years, the bankers say they will have to satisfy themselves on a number of technical problems in addition to the usual credit considerations. Such problems include the ability of the company's routes to produce the traffic required to service the loan, suitability of the airline's equipment for its routes and traffic, obsolescence of the flying equipment and non-flying facilities, and adequacy of spare parts purchases and of ground facilities.

The credit factors include the usual appraisal of management, the airline's operating record, and an analysis of its future prospects. Beyond that, the lender will want to be sure that the company has a sound capital structure. In this respect the banking and insurance study sets up a yardstick that the capital base of an airline should consist of at least 50 percent stock ownership.

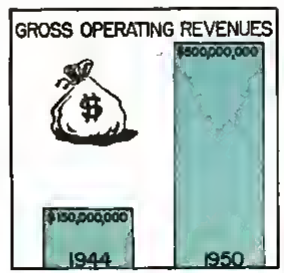
At present, of course, the capitalization of nearly all the airlines consists of common, and in a few cases like United Air Lines, preferred stock. But as the expansion program materializes not only will the amount of stock outstanding increase in many cases, but the feature of funded debt will appear on balance sheets for the first time in substantial amounts. Thus the proportion of stockholders' equity in their companies is bound to decline materially.

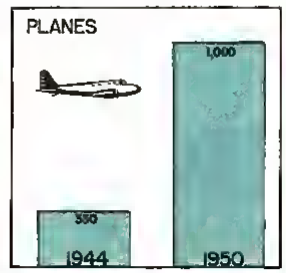
The question of obsolescence is one into which the lenders will delve with unusual care, for that will be the crux of any airline lending program. In the past, loans have been amortized, generally, on a 3-5 yr. basis. But on the larger and newest equipment planned for the post-war period it is believed that the amortization life for loans on such airplanes may be extended up to 8 or 10 yr. in certain cases. In any event the bankers probably will require that equipment loans will be fully paid up by the time the equipment is written down to a nominal value by the borrower.

Use of jet propulsion is cited in the report as an example of factors that may revolutionize aircraft power, accordingly hastening obsolescence of conventional engines. The opinion is expressed, however, that such radical changes need not necessarily endanger equipment loans if they are made for a medium term period. Furthermore, it is pointed out, such loans can be reduced by normal amortization while new types are being substituted for existing equipment. The airline should have an equity of 20 to 30 percent in its equipment at the time it floats the loan.

Fact that the airlines will need huge amounts of capital for their expansion programs in the next 5 yr. does not mean that any radical change in the industry's financial picture will take place immediately. Right now most airlines are well fortified with cash resources to take care of their expansion needs this year and possibly well into 1946. It is extremely doubtful if many of the new and costly transports which the lines have conditionally ordered, to the tune of $250,000,000, can be delivered until late in 1946.

On the other hand, some lines may wish to take advantage of favorable stock market prices to float stock issues in advance of actual needs. But the stock that may be issued or the bank borrowings that may be made in the next 18 months probably will be comparatively small when stacked up against the amount of financing that will follow in the ensuing 3 yr.





Domestic airline fund requirements—$500,000,000; international route requirements—$250,000,000

DESIGNING TOMORROW'S PERSONAL PLANE

PART I

By RALPH H. UPSON, *Consulting Engineer*

Inaugerating a most important series by one of America's outstanding aeronautical consultants, dealing with all phases of problems to be whipped in developing aircraft for the mass market . . . This first article coesiders the basic approach to engineering the lightplane for safety, economy, and performonce.

SAFETY, ECONOMY, PERFORMANCE—these are the indispensable factors in the design and utility of any personal airplane. But the greatest is performance. This supremacy of performance is made clear at the start, lest time spent later on other items should lead to a different impression. Broadly considered and applied, performance can be said to represent the airplane; certainly, safety and economy are both meaningless without it; but with it we have at least something of value, something on which to build.

By performance, I mean primarily performance *in the air*, not on the highways, in the water, or in the hangar. There is no intent here to cast unconsidered reflection on wholly praiseworthy attempts to develop satisfactory roadable or amphibious types (to be discussed more fully in later articles). There is only intent to emphasize that our first concern must be the airplane in its own element. Fundamentally, this means: Get the ship out of the hangar, make it work for a living, as any honest, capable airplane can and must do.

Here, an inevitable question may as well be brought up: "Why speak only of the airplane; what about the helicopter?" The helicopter is certainly here to stay. Any aircraft with such unique takeoff, landing, and hovering ability is bound to have its place in the general scheme of things. It will be supreme for any requirement of getting into the air and down again in a small space.

But, based on present knowledge of the art, it is quite limited compared to the airplane, in speed and range. A helicopter can apparently be made to equal present lightplanes in speed, although not in range, with about double the engine power and probably double the inspection and upkeep cost. Its control, as yet, is too complicated for the average novice to master with assurance and safety. More basically, by its very nature, it must always "travel in circles" to get anywhere.

In personalized or any other transport over a considerable distance, the helicopter can hardly displace the airplane. Its better chance of competition appears to be with the automobile, over less-than-airplane distances, if present economic and operating problems can be satisfactorily solved. We return, then, to the subject of this series—the airplane.

A Lightplane Is No Light Job

Probably the first thing to be attacked is the still too prevalent notion that efficiency and refinement of design are unimportant for a plane of relatively low speed and carrying capacity. Nothing could be further from the truth. The performance requirements themselves are, to be sure, on a different scale from those of military and transport aircraft. But for the magnitude of load, speed, range, takeoff, landing, and other items that *are* specified, it is perhaps even more important to meet these requirements with the minimum of power, weight, and cost.

Long past is the day when a new airplane could be counted a success if it merely flew and delivered in accordance with predictions. The handwriting on the drafting board is only too plain. No new airplane in the future can justify itself nor long endure unless in basic arrangement and in every part and process it comes close to the best available for the purpose.

Although there is, of course, no real substitute for competent personal attention to specific problems, there are many aspects of design in this field which can now be generalized, from available results of research and experience, and put into more practical engineering form than has hitherto been possible. Among the sources of scientific data, both theoretical and experimental, we have the great mines of available information in the NACA and in similar institutions in other countries; papers from the IAS, RAS, SAE, and other technical societies; university research work; magazine articles; and text books. In the field of practical experience there appear to be,

strangely enough, more new and usable development data available to the lightplane designer from military and transport types than from his own.

After all, airplanes in any category involve much the same *kind* of problems; but those of high carrying capacity and performance have hitherto had more attention in respect to their aerodynamic and structural requirements. Hence, although a lightplane *can* be designed by relatively primitive methods, maximum safety, efficiency, and performance cannot be had without applying most of the measures found indispensable in the high performance category.

This is far from implying that cost is to be neglected for, as will be brought out later, economy of weight and cost comprises a fundamental basis of evaluating prospective improvements. Many of the further points involved are simply a matter of doing a job right or wrong—with little to choose from in direct cost.

There are at least three major exceptions, however, to the application of high performance technique to lightplane design:

1. The relatively low speed in which we are interested (well under 300 mph) eliminates any consideration of compressibility effects, except at the propeller tips.

2. The low wing loading (maximum assumed being on the order of 15 lb/sq. ft.), satisfying present desired takeoff and landing distance, implies a somewhat different type of wing construction if excessive wing weight is to be avoided.

3. The much greater importance to lightplanes of simple control dictates the need for development in that respect. But as the advantage of simple control is by no means confined to such planes, the resulting developments may be extended to other types as well, in similar manner to the tricycle landing

gear originally developed for lightplanes.

For all aspects of design dealing with the production, utility, and servicing of accepted standard parts, the importance of reviewing actual experience, records, and users' reactions in the lightplane field is obvious enough to need no further comment here.[1]

What Is le the Cards

Another source of information for the designer, seemingly over-emphasized of late, is "the man in the street"—that old standby, always ready to give advice on any subject from military policies to designing an airplane. As a result of various polls, he is represented as definitely wanting a postwar airplane (or helicopter) but as expecting to pay prewar lightplane prices for performance and equipment which by prewar standards would cost five to ten times as much.[2]

These remarks are not by any means meant to belittle the value of such polls if properly timed and interpreted. After all, Mr. and Mrs. John Q. Public are the people we must serve and satisfy if we are to get out of the class of "taking in each other's washing". Yes, the potential users certainly should be consulted. However, there is a fallacy in this picture—the apparent failure to realize that at the present stage of the game, the initially important thing is not what people want, but what we can give them.

For example, the public is quoted as wanting a plane to carry three to five people at a cruising speed from 120 to 150 mph with a range of 500 mi. Now the only rational interpretation of such figures is that they represent a vague idea of what can perhaps be had without excessive cost or other great penalty. Otherwise there'd be no reason for not wanting more of everything.

In reaching a conclusion as to whether these various desires, separately or in combination, are reasonable, let us consider first what we already have in present lightplanes, including certain important features which seem to be taken more or less for granted. These can then be supplemented by well proved practice adaptable from other classes of airplanes, and by basic design studies dealing with known components. (The somewhat more nebulous future possibilities, of uncertain value or not yet thoroughly explored, will be left for later articles.) We consider here not what is in the stars but what is in the cards.

The most notable feature common to practically all present personal airplanes is the relatively low wing loading (8 to 12 lb/sq. ft.) which facilitates flight control and permits low-speed takeoff and landing. A light, cheap method of fabricating such wings is already at hand. By the use of flaps the wing loading (for an equal landing speed) can be increased at least 28 percent and, in some cases over 50 percent, the lower figure corresponding to elementary hinged flaps, the higher to a relatively simple slotted type. Flaps of a type appropriate to the general design are well justified on economic grounds, if nothing else.[3]

We shall tentatively assume also that the landing gear is fully retractable, that other incidental parasite parts can be dispensed with, and that good streamlining of major parts can be used. Other features proven worthwhile, including spinning and simplified control, can be retained without unfavorably affecting performance. The immediate question is then: "What is a reasonable performance aim", or more specifically, "How far can we go by cleaning up the present light plane, reduced to wing, fuselage, tail and power plant?"

The Wages of Cleanness

Valuable direct evidence on the above question is given in an NACA wind-tunnel study[4] on wing, fuselage and tail combinations (although the wing root and fuselage rear are thicker than necessary for a light plane of the other proportions listed.) All the models tested, if stepped up in size by 14.4 times the linear dimensions would give a full-scale span of 36 ft., fuselage length 24.2 ft., width and height 4.12 ft., (49½ in.), and wing area 216 sq. ft.

The minimum drag coefficient (excluding induced drag) of the complete models (with tail surfaces) varied from .0128 to .0142 at a Reynolds number of 8.2×10^6. The later condition is attained by assuming that the plane flies 150 mph at 7,000 ft. By taking a conservatively high value of C_{D_0} equals .0139 and multiplying by the wing area we get a drag area of 3.0 sq. ft. as representing all drag except induced and power plant. With a power plant increment, reasonably estimated from experience, at 0.5 sq. ft. for a well cowled engine, we get a total drag area $f = 3.5$ sq. ft., of which the wing contributes 2.0 sq. ft.

An assumed gross weight of $W = 2{,}250$ lb. gives only 10.4 lb./sq. ft., which with fairly good flaps ($C_{L_t} = 2.0$) would permit an honest landing speed of 45 mph, certainly a sufficient concession in the matter of wing loading. If the Oswald span factor e is given a conservative mean value of .85, including the tail load factor, the basic thrust-power equation for level flight can be conveniently written:

$$\eta hp_r = \frac{\sigma v^3 f}{146{,}600} + \frac{0.39\ W^2}{\sigma v b^2} \qquad (1)$$

where η is propulsive efficiency, hp_r the brake horsepower required, σ the relative air density, and v the true airspeed in *mph*.

Estimating $\eta = 0.8$, with $\sigma = 0.811$ for the 7,000-ft. altitude, and with the other values as set down above, the brake horsepower, $hp_r = 97.3$ at the assumed airspeed of 150 mph. To justify calling this the cruising speed the rated engine power should be at least 125 hp., making the maximum for cruising 78 percent of rated (high but commonly used). At 120 mph a better speed for getting range, the cruising power is reduced to 61.3 hp. At a good, though not phenomenal, fuel consumption of 0.49 lb./hp. hr., the fuel would be burned at a rate of 30 lb. (5 gal.) per hr., or 25 gal. for 600 mi. This 20 percent reserve over the desired 500 mi. seems sufficient for circling the airport, attaining altitude, and even a little for head winds and "dead guessing" (a common form of dead reckoning).

Structural improvements permitting a reduction of weight appear also to be currently possible, but these will be tentatively assumed counterbalanced by any weight penalty that may be involved in drag reduction and by the increased demand for new features and equipment. Even so, the assumed gross weight of 2,250 lb. is believed sufficient to take care of three or four persons, and by stepping up the gross weight and wing loading, five could readily be carried with but little increase in power and general dimensions.[5]

Thus the desires of the man in the street appear not at all absurd. General fulfillment of his outside performance hopes is shown to be possible by "cleanup" methods alone. That an attainable drag area of 3.5 sq. ft. is not hopelessly underestimated is further shown by the fact that one of our best known fighters in service today has but little more drag area, although with considerably more wing area and many times the weight and power. Although two or three lightplane designs of the immediate prewar period show real improvement, the drag area of a typical lightplane of the present day remains about double the "ideal" figure here.

Table I—Effect of Increased Drag Area

Cruising speed	150 m.p.h. at 7,000 ft.
Useful load less fuel	700 lb.
*Wing loading	10.4 lb./ft.
Aspect ratio	5
Range at 120 m.p.h.	500 mi. plus 20% reserve

A. Airplane of Minimum Drag (NACA TR678).
B. Airplane of Present Conventional Design With Above Performance Obtained by Increased power and Fuel.

	A	B	
Initial drag area (sq. ft.)	3.5	7.0	(for equal size and power)
Final drag area (sq. ft.)	3.5	11.9	(including additional wing area and drag)
Wing area (sq. ft.)	216	364	
Gross wt. (lb.)	2,250	3,690	
Empty wt. (lb.)	1,400	2,480	
Rated power (hp.)	125	425	
Relative wt. empty	1.00	1.77	
Relative engine power and fuel	1.00	3.40	

*For equal landing characteristics (take off assumed non-critical).

The Wages of Uncleanness

The real penalty of thus doubling the attainable drag is most forcefully brought home, not by a comparison of performance, but by comparing the weight and power required for the two cases, assuming equal performance. The customer says he wants 150 mph. All right, he can have it; if not by drag savings, then by increase of power and weight. What would the latter amount to on the basis of present typical design? For a preliminary answer to this question, any saving in weight, due to the fixed landing gear of the conventional design, and increased wing area and weight, due to the absence of flaps, will be equally neglected.

Starting with the airplane of minimum drag already outlined, the first effect of doubling the drag area (at equal speed) is obviously to double the first term of the power equation (1), increasing the total power 84 percent. This power increase requires nearly a proportional increase in power plant and fuel weight (for equal range).

For equal wing loading, the corresponding weight addition in turn increases the wing area, drag, and weight, with incidental effect on the landing gear and tail. This further weight and drag means a still larger power plant, wing, etc., a zoom-like process at the top of which the required rated engine power is found to be something like 300 hp. more. In our accompanying Table I, comparative figures are brought out.[6]

As the first cost varies almost as the weight for similar types of construction, and the direct operating cost is largely dependent on the engine power, the importance of design suitability is seen to be of dominating importance. The reason that such differences are not more often recognized is because they are usually camouflaged by the acceptance of a different performance level, the direct effect of which is practically impossible to evaluate.

To summarize, we have set up a picture of what should be possible performance for a personal plane of reasonable size and power. How closely such performance can be approached in the immediate future depends on specific arrangement and other factors of practical importance. In particular, we have yet to consider the basic placement and form of major parts—wings, fuselage, engine and landing gear.

If a clean cantilever wing is to involve excessive weight or cost, its low drag will be only of academic interest. If the fuselage and engine arrangement of minimum drag and weight is fatal to vision, a compromise must be sought. A low wing obviously facilitates landing gear retraction but still must be considered in relation to possible disadvantages.

There are more items of performance than speed and range; design favorable to one may interfere with others; and none are acceptable without stability and control. It may be admitted that even a large sacrifice might conceivably be accepted in return for some phenomenal economic saving; though it must be emphasized that the way to judge such a case is to adjust the weight and power of the two or more designs in question to as near equal performance as possible.

In other words, we have found out how far we might go in the direction of the major performance objectives. As to whether we *want* to go that far, and, if so, by what route, remain to be determined.

[1] See S. J. Stelle's article "Structural Design Problems of Light Aircraft". *Aeronautical Engineering Review*, Feb. 1945.

[2] Discussed in detail by J. Carlton Ward, Jr., in article, "The Post War Plane," *National Aeronautics*, Feb. 1945.

[3] See author's article, "Save Money by Spending It," AVIATION, Sept. 1944.

[4] A. Sherman, "Interference of Tail Surfaces and Wing and Fuselage," NACA TR 678.

[5] The basis for such estimates will be brought out in next article.

[6] Based on author's weight data given in AVIATION, Sept. 1944, to be summarized more completely in next article of this series.

DESIGN DETAILS OF

AERONAUTICAL PRODUCTS, INC. HELICOPTER

Written and illustrated by CHESTER S. RICKER,
Detroit Editor, "Aviation"

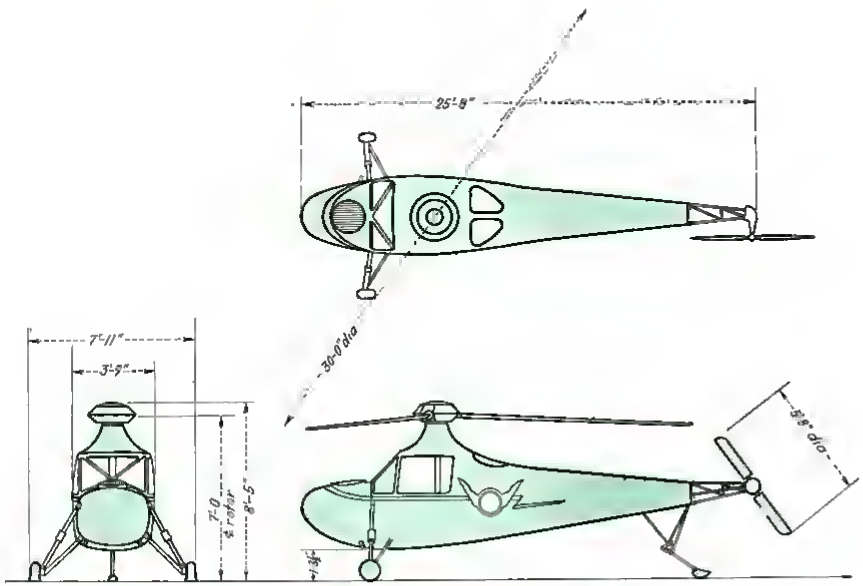
AERONAUTICAL PRODUCTS flying laboratory — NX-1272 — is the first rotary wing venture of this aircraft engine parts manufacturer.

It is unorthodox in many respects, a fact quite in keeping with the personalities of its co-developers, the late Alfred Jackson, his partner Charles C Layman, now president, and designer Frank Dobson.

Fuselage is conventional in appearance and construction, being made up of welded steel tubing, extending from the engine mount in front to tail skid and anti-torque rotor, all fabric covered. An auto-type door on the right side gives access to side by side hammock-type seats attached to a steel frame that is an integral part of the fuselage structure. Leather covered hair filled cushions rest on the hammock seat.

Main landing gear wheels, set just forward of the cabin, are attached to oleo struts and the tail skid has a bungee cushion which has been found to keep the craft steadier on the ground than did a more resilient oleo.

Unlike other helicopters, NX-1272 has its 165-hp six cylinder Franklin



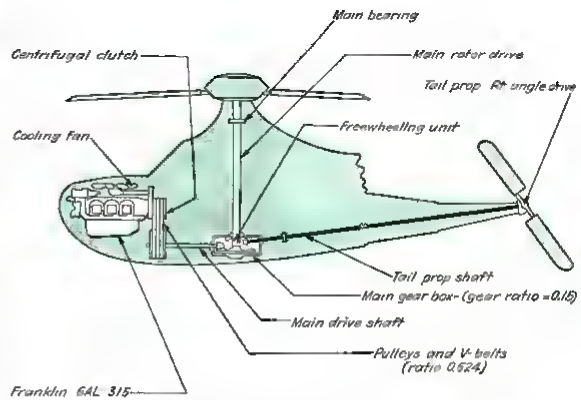
Phantom view showing arrangement of anti-torque rotor control

Here are first engineering details and sketches of prototype created and built to test theories and manufacturing methods designed to produce low cost rotary wing craft for postwar markets.

engine mounted in front of the cabin as it would be in a conventional airplane. This location makes it more accessible—by removing a one-piece cowling—for servicing, and simplifies cooling.

A six-blade, 18-in. diameter fan is mounted directly above the engine, just below a large diameter opening in the cowling, and cylinders are shrouded so that cooling air is distributed evenly over them. A V-belt fan drive pulley is attached to the main power take-off pulley at the rear of the engine, driving a horizontal shaft above the engine. Enclosed bevel gears at the front end drive the vertical shaft attached to the fan.

Power is transmitted by six 1-in. V-belts to main and anti-torque rotors through an 8-in. pulley driving a 12-in. pulley on the intermediate drive shaft set in the lower part of the fuselage. This intermediate shaft extends back to the main gear box at the base of the



Cross sectional view of Aeronautical Products Inc. helicopter, showing general arrangement of power plant and transmission units

main rotor shaft, is carried on two ball bearings; one in front of the driven pulley and mounted in the fuselage, the other in the gear box

An adjustable spacer tube carried on ball bearings at each end of the shaft relieves the over-hung engine drive pulley shaft and intermediate drive shaft from bending strains due to belt tension. It is not a solid connection, as a double rubber washer cushion beneath the adjusting plate will allow for slight variations in misalignment that may take place due to flexing of the fuselage in flight or landing The upper part of the spacer carrying the nut telescopes in the tubular lower member, but is not fastened to it.

The engine drive pulley unit contains a centrifugally-operated friction clutch which permits the engine to be started and idled without turning the main rotor since it will not engage below 1,300 engine rpm It has been found a very satisfactory control

Use of the pulley-belt power drive provides both a flexible and shock absorbing connection between engine and rotors that has proved very efficient in eliminating vibration in the fuselage due to cyclic variations in main rotor drive.

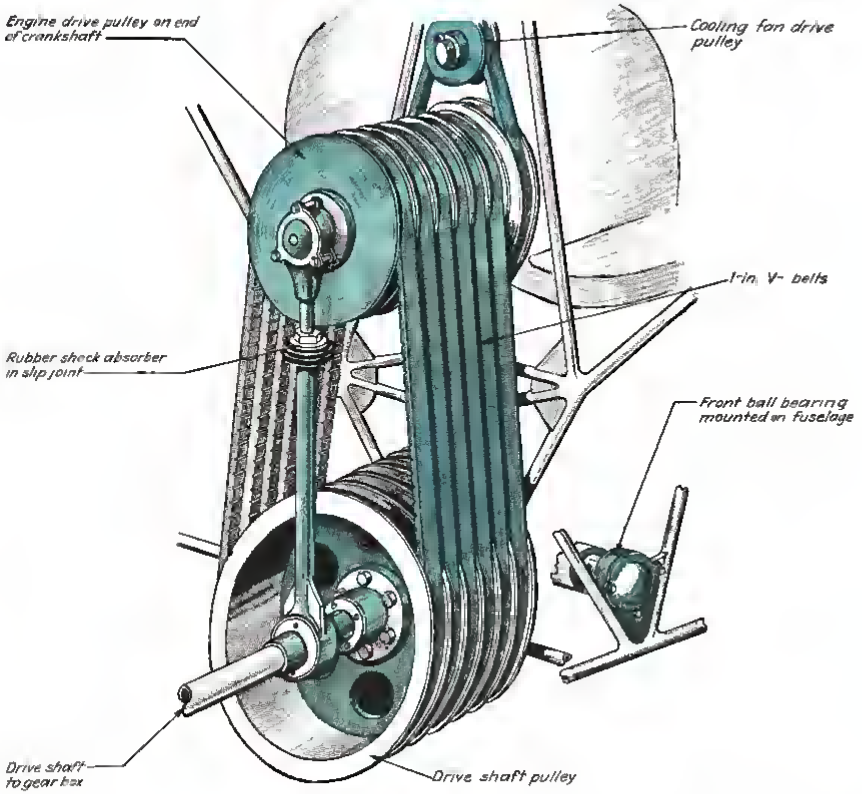
Simplicity and light weight were dominating factors in designing the main gear box, which is set in the lower fuselage beneath pilot and passenger seats. A bevel gear on the end of the intermediate drive shaft engages a larger horizontal gear connected to the main vertical rotor drive shaft through a ratchet type over running clutch

Use of this unit permits auto rotation of main and anti-torque rotors in case of engine failure. Location of the unit at this point instead of on the engine shaft decreases friction and permits autorotation even if the main driving gears should fail. All gears run in an oil bath, and all shafts have spring type oil seals to prevent leakage.

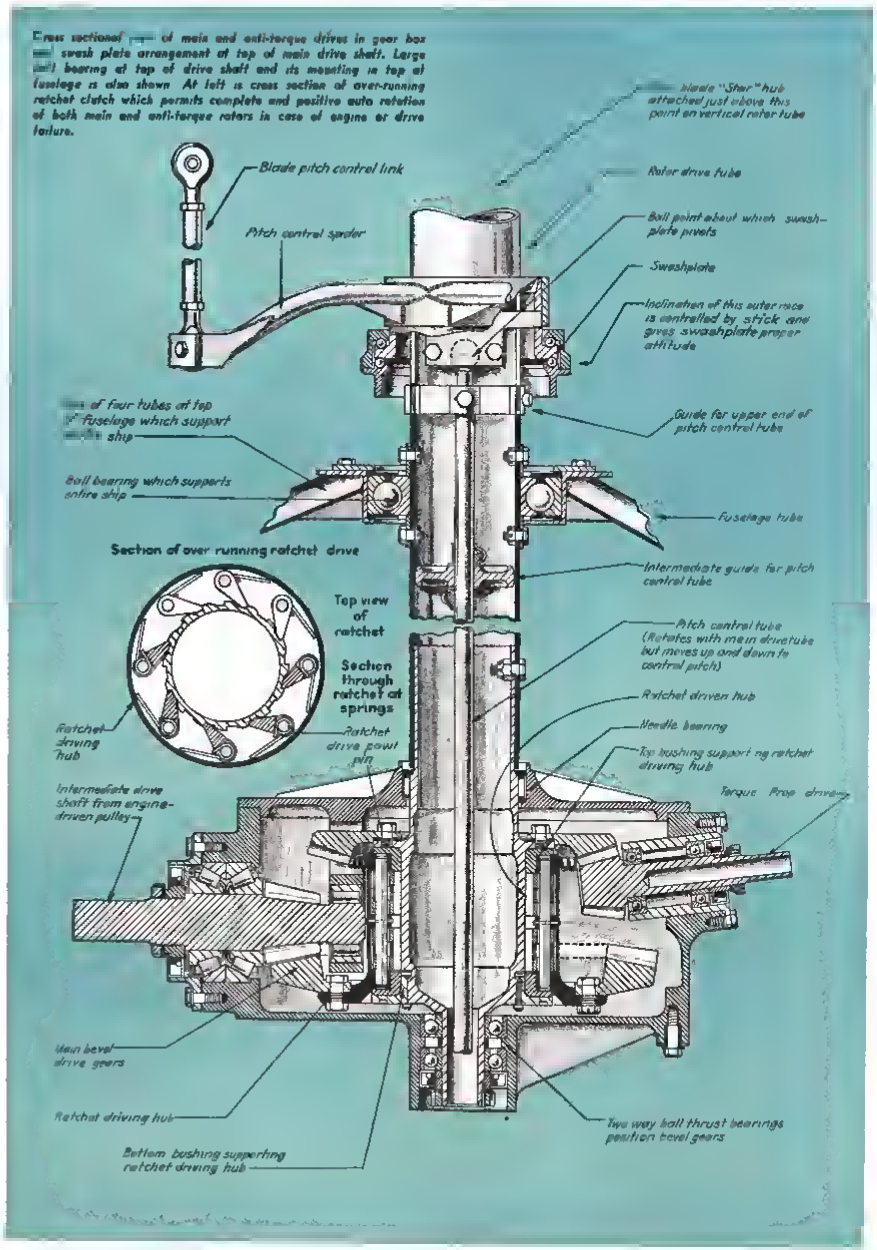
Mounted on the vertical rotor drive shaft near the top of the gear case are anti-torque rotor drive bevel gears whose axes are approximately 84 deg. By using this angle it has been possible to secure a straight line drive from the gear box to the anti-torque rotor, Its drive shaft is 1-in OD heavy wall tube 16½ ft. long, steadied by five ball bearings spaced 2 ft. 9 in apart Just back of the main gear case is a fabric type universal joint which serves both as an alignment member and a simple, easily-assembled coupling

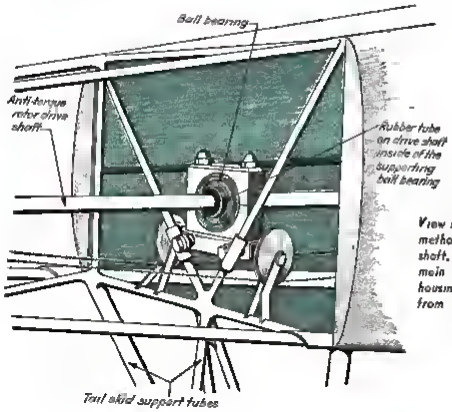
This drive shaft runs at about one

Sketch showing details of multiple V belt drive from forward-mounted engine to intermediate drive shaft connecting with main gear box.

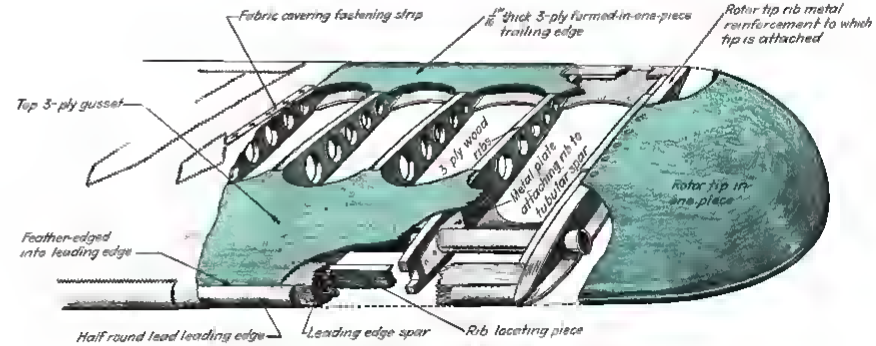


Cross sectional [illegible] of main and anti-torque drives in gear box [illegible] swash plate arrangement at top of main drive shaft. Large [illegible] bearing at top of drive shaft and its mounting in top of fuselage is also shown At left is cross section of over-running ratchet clutch which permits complete and positive auto rotation of both main and anti-torque rotors in case of engine or drive failure.

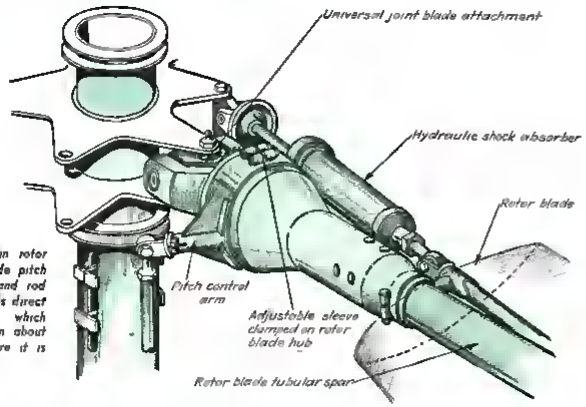




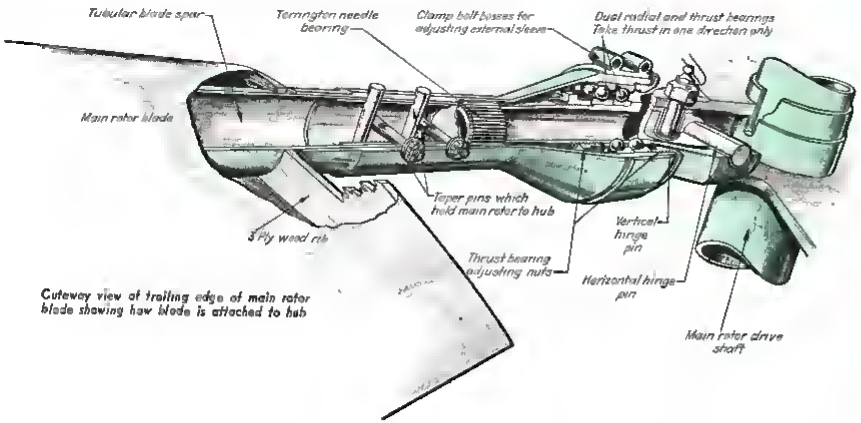
View near aft end of fuselage, showing simple method of supporting anti-torque rotor drive shaft. Five such bearings are used between main gear box and anti-torque rotor gear housing. Also shown are cables extending from rudder pedals to anti-torque rotor.



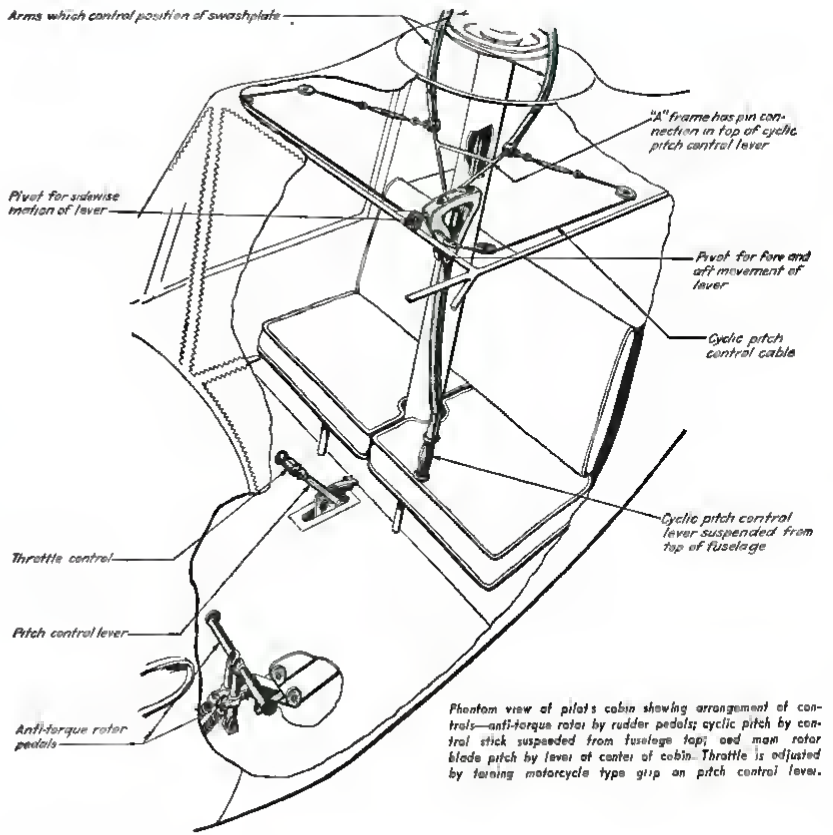
Cutaway sketch at main rotor blade tip, showing 3-ply ribs, 3-ply gussets and how latter form leading and trailing edges.



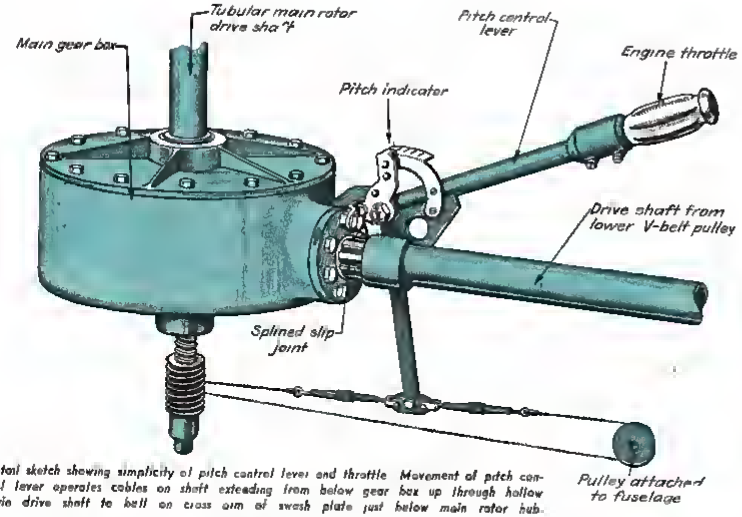
Sketch illustrating mounting of main rotor blade on star shaped rotor hub. Blade pitch control is obtained by lever arm and rod seen to left of blade hub. At right is direct acting hydraulic shock absorber which steadies blade and limits its motion about vertical axis of universal joint where it is attached to hub.



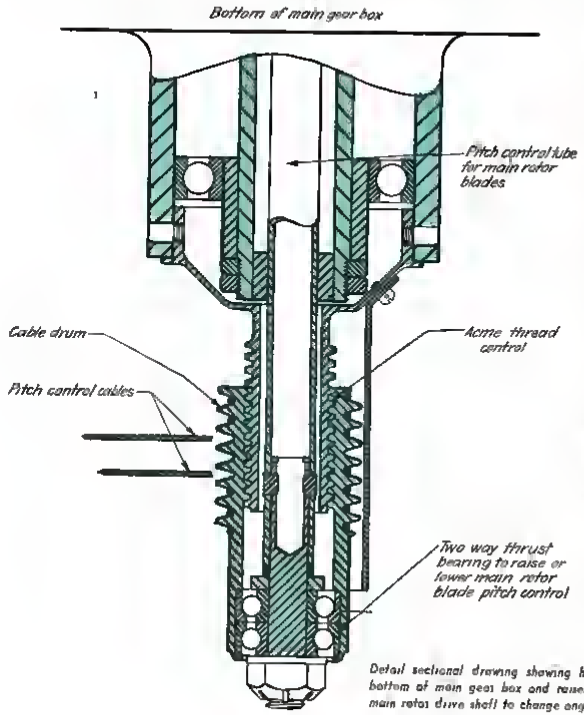
Cutaway view at trailing edge of main rotor blade showing how blade is attached to hub



Phantom view of pilot's cabin showing arrangement of controls—anti-torque rotor by rudder pedals; cyclic pitch by control stick suspended from fuselage top; and main rotor blade pitch by lever at center of cabin. Throttle is adjusted by turning motorcycle type grip on pitch control lever.



Detail sketch showing simplicity of pitch control lever and throttle. Movement of pitch control lever operates cables on shaft extending from below gear box up through hollow main drive shaft to bell on cross arm of swash plate just below main rotor hub.

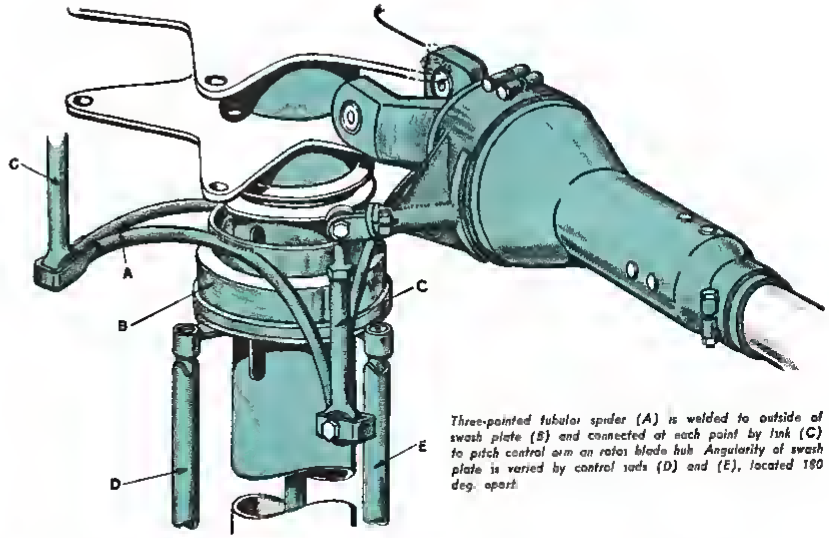


Detail sectional drawing showing how pitch control is mounted on bottom of main gear box and raises or lowers vertical tube through main rotor drive shaft to change angle of attack of main rotor blades

half engine speed, so that its small diameter is sufficient to take the torque. To give quieter operation and allow for deflection of the structure and drive shaft it has been found practical and economical to use ¼-in. thick wall rubber tubes between the drive shaft and the inner races of the support bearings. The cushion thus gained has eliminated drive shaft failures, prevented whip and made it unnecessary to grind bearing seats on the outside of the drive tubing. It is a typical example of the manufacturing economies practised throughout the craft.

Main rotor drive shaft is a 3½-in. tube which also supports the weight of the craft through a large ball thrust bearing at the top of the fuselage. Thus only a short section of the drive shaft has to carry both load and rotor torque. A needle bearing at the top of the gear case and ball thrust bearings at the bottom maintain vertical alignment of the entire fuselage relative to the drive shaft. The main drive shaft telescopes over a projecting hub in the top of the gear case. This facilitates producing parts in subassemblies.

The main rotor drive shaft extends up through the fuselage between pilot and passenger seats and is housed in a sheet metal tube. While it is not objectionable as a functional member, it will definitely eliminate "one arm"



Three-pointed tubular spider (A) is welded to outside of swash plate (B) and connected at each point by link (C) to pitch control arm on rotor blade hub. Angularity of swash plate is varied by control rods (D) and (E), located 180 deg. apart.

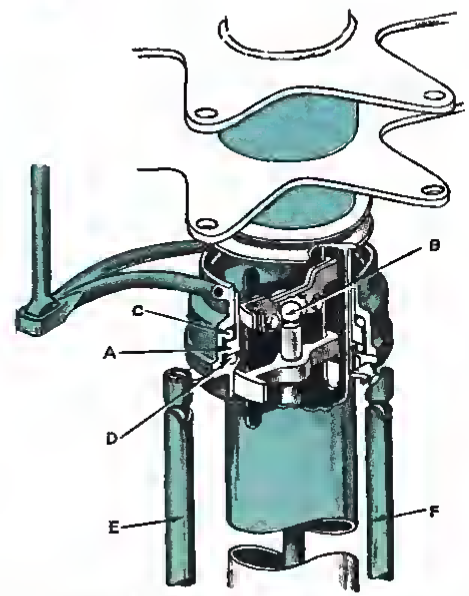
flying, even on the most beautiful of moonlit spring nights.

Heart of the main rotor hub consists of two six-pointed star-shaped steel plates set one above the other. Three of the points, spaced 120 deg. apart on upper and lower plates, provide attachment for rotor blades. Vertical pins connecting the plates pass through a steel block containing a horizontal pin going through a fork forming the inner end of the rotor blade, thus establishing a universal joint attachment.

The rotor blade hub, in turn, is mounted on the fork handle—which API engineers refer to as the blade stub shaft—on two combination radial and thrust bearings just inside the blade hub carry the centrifugal load, while a large needle bearing on the outer end of the stub shaft aligns the blade. The root end of the blade spar, which is attached to the spar hub by two vertical and two horizontal taper pin bolts.

Main rotor blades form a disk 30 ft. in diameter and are built with tapered tubular spars and wood ribs reinforced with plywood gussets fabric-covered. The leading edge is armored with a half-round lead strip.

At the trailing edge of each main blade is a double acting hydraulic shock absorber which is attached to the main rotor hub at the secondary points of the "star" plates by universal forks, and through a ball and socket joint to a tube projecting out from the root of the blade about half way from



Cutaway sketch showing action of pitch control. Top of tube extending up through main drive shaft from below gear box is ball seated and entire swash plate inner ball thrust (A) is supported by cross arm atop ball joint (B). Outer swash plate races (C) and (D), which are clamped together form non-rotating part of swash plate, angularity of which is modified by rods (E) and (F), thus controlling cyclic pitch of blades. (E) and (F) are connected to control stick by cables in one direction and A-frame in opposite direction.

the blade's axis to the trailing edge.

This unit limits the swing of the blade about the vertical hinge pin of the universal joint mounting. Movement of the blade, it will be noted, is one in which the blade seeks a point of equilibrium for each control position. Stops are provided to limit blade motions when at rest or starting and stopping through a cage set atop of and fixed to the main drive shaft.

The engine throttle is opened or closed by means of a motor-cycle type grip on the end of the main rotor pitch control lever, which is set at the pilot's right, just in front of and mounted on the main gear box. A pointer on the lever sweeps over a quadrant graduated in pitch angles, so the pilot can see at a glance the exact angle of attack of the blades.

The pitch control lever operates a continuous cable wound around a drum which turns as a nut. Ball thrust bearings transmit this rotary motion to axial and raise or lower a tubular shaft extending down through the bottom of the gear box. The upper end of this shaft carries a ball joint inside the hollow main rotor drive shaft about which a cross arm supporting the inner thrust ball race of the swash plate rocks.

This vertical shaft turns with the main rotor drive shaft, and the swash plate cross arm extends out through its wall to the inner race of the swash plate through two diametrically opposed slots. Welded to the outer race housing of this swash plate are tubes having ball and socket joints at their outer ends. Adjustable vertical rods extend up from the joints to universal joints welded to levers extending out from the rotor blade hub. Thus, by moving the swash plate up, this linkage swings the blade spar about its axis to increase the blade pitch.

Cyclic pitch control is achieved through a control stick which is universally mounted at the top of the fuselage. This construction was decided upon not only to keep weight down, but to provide simple yet positive control. Moving the stick forward imparts control through a universally-mounted quadrant attached via an inverted A-frame to two rods extending up alongside the main drive shaft to the outer race of the swash plate to tilt it forward and reduce pitch of blades forward of the shaft. An opposite motion reverses the control. Sidewise motion of the stick moves the swash plate at right angles to those motions via adjustable cables attached to the A-frame.

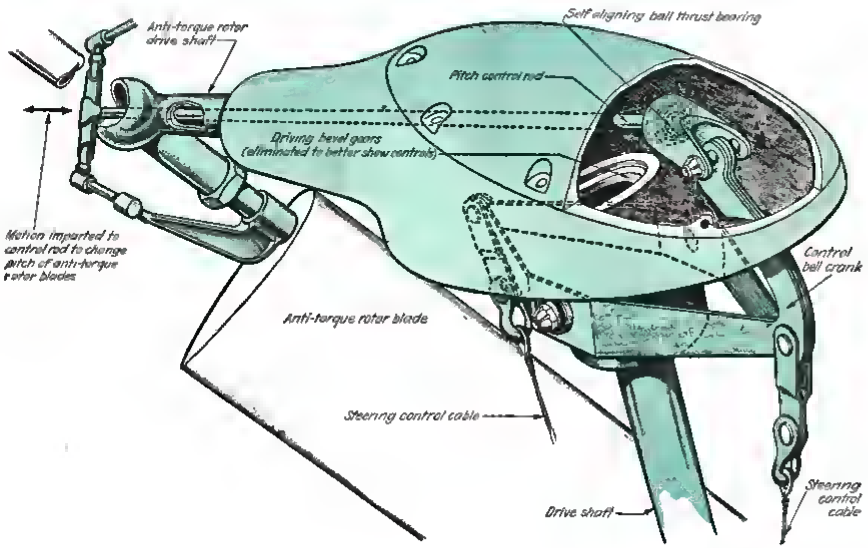
Stick-to-swash plate movement ratios and swash plate lead ahead of cyclic pitch movement cannot be revealed at this time, but in test flying in the craft the writer noted that response to the controls was at all times positive and showed no signs of sluggishness.

The 5-ft. 8-in. diam. two bladed variable pitch anti-torque rotor is mounted at the aft end of the fuselage and is controlled by cables running aft from conventional rudder pedals.

These cables are attached to a cross bar and bell crank, the arm of which goes into the cast housing for gears which change direction from the rotor drive shaft 90 deg. to the rotor hub. A connecting rod from the bell crank extends through this hollow shaft and rotor hub to a T-bar connected through adjustable ball and socket links to pitch control arms on the blade roots. A light metal guide housing bolted to the rotor hub causes the control shaft to rotate with the drive shaft, at the shaft's inner end a ball and socket mounted ball thrust bearing is provided in the hub of the shifter yoke. Since this latter unit is inside the cast gear housing, it is completely protected from the elements.

Although NX-1272 in its present state can be considered a successful helicopter, it should be no means be considered a finished product—to its creators it remains a flying laboratory built solely to test theories and to determine the most efficient means of building a stable, easily-controlled craft that can be marketed at a reasonable price.

Phantom view showing arrangement of anti-torque rotor control.



See Prime Role for Gas Turbine In Aircraft of Tomorrow

By CHARLES D. FLAGLE, *Design Engineer, Aviation Gas Turbine Div.,* **and FRANK W. GODSEY, Jr.,** *Manager, New Products Div., Westinghouse Electric Corp.*

Coincident with Westinghouse's announcement of its aviation gas turbine project for the Navy, company engineers compare characteristics of the conventional power plant, jet engine, and geared turbine-propeller unit, outlining probable fields of use for these prime movers.

THROUGHOUT ITS HISTORY, aviation progress has been paced by the development of airplane engines. The constant trend has been toward larger and faster planes—consequently toward more powerful engines. Until recently, planes were driven only by reciprocating internal combustion engines. Now there are new power plants and of them, two will undoubtedly figure largely in aviation of the near future—the jet propulsion engine and the gas turbine-propeller unit. Both will have continuous combustion gas turbines as prime mover.

The use of gas turbines in aircraft will eventually result in new design concepts for air transportation, and comparison of the new power plants with conventional engines should properly be made on the basis of finished planes designed to best fit the characteristics of their particular power units. Test stand fuel consumption rates offer a good measuring stick for engines of similar types, but such a rate should not be used as a primary figure of merit in comparing different types. Size, weight, and cooling requirements of an engine, together with its efficiency in converting fuel energy into thrust horsepower and the ease with which it is installed in clean, low drag airframes, determine its real economy.

While the reciprocating engine will undoubtedly continue to hold its present position in the field of low power and for planes of low speed, the gas turbine will come into its own both as a jet engine and for driving propellers in high powered planes and for high speed flight.

Of the three types of power plants, the gas turbine-propeller engine has characteristics that give it superiority over the reciprocating engine in all speed ranges and over the jet engine at low and intermediate speeds. The jet is preëminent in the highest speed range. Fig. 1 shows the probable fields of use of the three types.

These conclusions are reached by comparing the performances of planes in which each of the three types of engines might be installed. Before proceeding with this comparison, however, it would be well to discuss these engines individually.

The development of the modern reciprocating aircraft engine is one of the great technical achievements of our age. However, power ratings have reached a point where further major increases can probably only be attained by improvements in fuels or addition of cylinders. Engine diameter

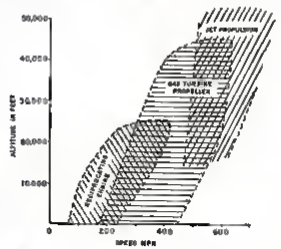


Fig. 1. Probable fields of use of three types of aircraft power plants of near future.

or frontal area is already limited by allowable piston speeds; larger engines are longer engines, and specific weight is more apt to increase than decrease with power rating. Fig. 2 illustrates the probable trend in future specific weights for large engines. And reciprocating engines capable of delivering several thousand horsepower require controls, accessories, and exhaust disposal systems which complicate installation and maintenance problems to an extent that limits further large increases in power rating.

The reciprocating engine is by nature adapted to cruising flight rather than sustained high speed flight. Highest efficiency and greatest reliability are achieved only when it is operated below 60 percent of rated power. Fig. 3 shows some typical fuel rates at various operating conditions.

In jet propulsion, all power output of the engine is used to accelerate the air taken into the engine to a jet of approximately sonic speed, which is expelled through an exhaust nozzle. The resultant thrust experienced by the engine housing is the reaction to the force required to accelerate the intake air to its exhaust velocity. The gas turbine operates by inducting air, compressing it, adding heat at high pressure, and expanding the high temperature combustion products. Major part of the energy is recovered in expansion through the turbine blading and must be used to supply energy required for compression. Remainder of the expansion can be made to take place through a nozzle, where the energy appears as kinetic energy of the exhaust gases.

Gas-Turbine Jet Engine

One may ask why the gas turbine can be so well adapted to jet propulsion while the conventional engine cannot. The answer lies, to a great extent, in the fact that the gas turbine handles a much greater mass of air (four to eight times more than the

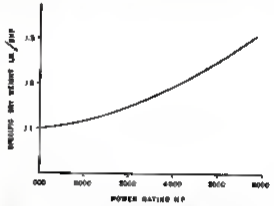


Fig. 2. Predicted specific weights of conventional engines. (From "Aircraft Power Plant—Past and Future" by Sir A. H. Roy Fedden.)

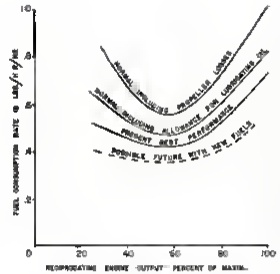


Fig. 3. Typical fuel consumption rates for large reciprocating aircraft engine under different operating conditions.

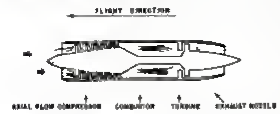


Fig. 4 Schematic illustration of aircraft jet propulsion engine with axial flow compressor and in-line combustor and turbine

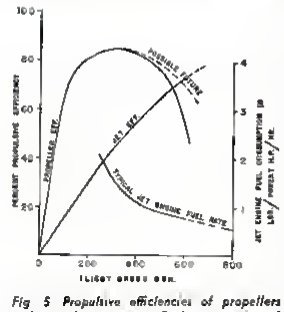


Fig 5 Propulsive efficiencies of propellers and jets of jet engines. Fuel consumption of typical jet engine is also shown.

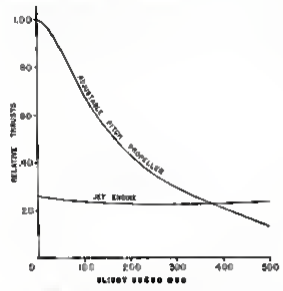


Fig 6 Relative propeller and jet engine thrusts with equal thrust power at 375 mph., at different flight speeds.

reciprocating engine for each pound of fuel burned) which leads to a more efficient jet reaction Difference is that the reciprocating engine requires a large mass flow of air for cooling external to the combustion space, whereas the gas turbine swallows its own cooling air and subjects it to the same thermodynamic cycle as the air needed just to burn the fuel The relatively high combustion temperatures of the reciprocating engine results in high speed exhaust gases with very unfavorable velocity ratios for jet flight at subsonic speeds

Fig 4 shows an axial flow type jet engine in which the compressor, combustion chamber, and turbine are arranged in-line, to present minimum frontal area. Some jet engines have been built using centrifugal compressors, giving a machine of larger diameter, not so well suited aerodynamically for installation in a high speed plane

Principal advantages of the jet engine are simplicity and light weight installed weight is little higher than dry weight, since little oil is required for lubrication, and the engine requires no external cooling provisions

Thrust is relatively constant over normal airplane speed ranges. Therefore, the rating of a jet engine is usually given in terms of thrust rather than hp and means nothing from a power standpoint until the speed is also given A thrust of 1 lb at 375 mph is equivalent to 1 hp At lower speeds the power rating decreases and at higher speeds it increases in direct proportion

An adjustable pitch propeller is capable of converting shaft power into thrust hp rather efficiently over a wide range of plane speeds, but the jet's efficiency is quite low at low speeds. This is shown in Fig. 5, where it can be seen that present jet efficiency does not equal propeller efficiency until flight speeds of about 500 mph are attained Below this, the jet efficiency —and consequently its fuel economy— is inferior Fuel efficiency of a jet engine is low, principally because of the jet efficiency characteristic, secondly, because the gas turbine operating at a low compression ratio is handicapped in efficiency At 375 mph, the apparent or test stand propulsive efficiency of a jet engine will be less that half of the conventional power plant. Takeoff thrust will be ½ of that of a propeller with the same power rating at 375 mph. (Fig 6). Jet propulsion gives excellent high speed performance at expense of range and low speed characteristics

It is significant to note that jet efficiency overtakes propeller efficiency in a speed range in which compressibility effects impose critical aircraft design limitations Much aerodynamic research must be carried out before jet propulsion can be utilized to its best advantage

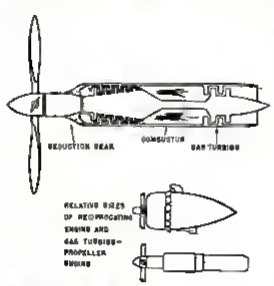


Fig 7. Schematic illustration of axial flow gas turbine-propeller engine.

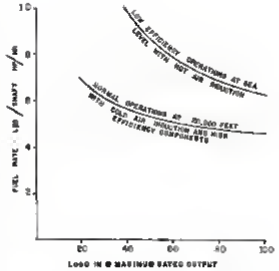


Fig. 8. Range of fuel consumption rates for aircraft gas turbines with reduction gear output to propeller shaft Rates have not been adjusted for exhaust jet thrust effects.

Gas Turbine-Propeller Drive

A simple open cycle gas turbine can be built today to work at a peak temperature (temperature of gases entering turbine) of 1,500 deg F With further metallurgical progress, the life of highly stressed turbine parts operating under high temperature will be increased, and the limiting cycle temperature may be elevated above 1,500 deg F. With a compression ratio of 10·1 and compressor and turbine efficiencies of 85 percent, a fuel efficiency of 26 percent can be achieved By increasing compressor efficiency to 87 percent and turbine efficiency to 89 percent, we may expect a rise in efficiency to 28 percent at standard sea level conditions At 15,000 ft., due to low ambient temperatures, the cycle efficiency rises to 31 5 percent.

A schematic illustration of a gas turbine geared to a propeller is shown in Fig 7. In appearance, the axial flow gas turbine for propeller drive

will be a symmetrical machine, its reduction gear concentric with its rotor Diameter will be less than half that of a conventional engine of comparable power—permitting it to be easily buried within fuselage or wing Presenting little frontal area and requiring no external cooling air, the gas turbine offers very little drag at high speeds. This, in addition to the fact that the turbine efficiency is best at peak loads, points to the adaptability of this type of power plant to high speed flight.

Efficiency of a gas turbine is highest at rated load and rated rpm. As rpm. decreases, the efficiencies of compression and expansion drop off, and compression ratio also decreases rapidly. Since useful power output of the machine is the relatively small difference between the power developed by the turbine and power absorbed by the compressor, any change in compressor or turbine efficiency is magnified in its effect on power output. And it is doubtful if the turbine output will be sufficient to drive the compressor, much less supply power to the propeller, at much below ½ rated speed. Idling speed for a gas turbine-propeller drive will be between ½ and ¾ rated rpm.

The turbine for propeller drive operates on four to eight times the quantity of air used by a reciprocating engine of comparable power. A large exhaust jet thrust is available to supplement the propeller, since normally about 20 percent of the useful power remains in the exhaust gases as kinetic energy. The proportion of useful power remaining in the exhaust to power delivered to the propeller can be controlled by the designer.

Installed weight of the geared gas turbine engine should be less than ½ the weight of the equivalent reciprocating engine installation.

In general, operations at normal flight altitudes are favorable to economical turbine performance. Fuel rates are indicated in Fig 8. It is interesting to note that for rough approximation purposes, the exhaust jet thrust just about compensates for propeller losses and nacelle and cooling drag, so that shaft power output of the turbine is about equal to the net thrust horsepower available.

The gas turbine is not a supercharged engine. Hence, the selection of power rating must be based on altitude requirements; and for sea level operation, considerable excess power will usually be available Typical power-availability curves for various types of power plants are shown in Fig. 9.

The reciprocating engine in its normal cruising power range is a very efficient means of converting fuel energy into shaft power However, its application to aircraft is complicated by many difficult problems, among which are the necessity for supercharging at high altitudes, severe vibration, excessive weight installed as compared with dry engine weight, and high nacelle drag and engine cooling power losses.

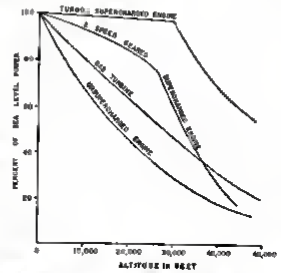


Fig. 9. Effect of altitude operations on power-availability of various typical aircraft engines.

For medium and long range craft, the most important problems are probably the reduction of nacelle drag and engine cooling losses Planes designed for low speed operation can afford to have a large part of parasitic drag absorbed in engine nacelle and engine cooling losses, since induced drag may be a large portion of the total flight power requirement and engine losses are a relatively minor factor This is distinctly not the case with long range and high speed craft where induced drag is relatively small and parasitic drag all-important.

The reciprocating engine presents considerable frontal area when placed in a wing nacelle, and the total profile area of power plant frequently exceeds that of the fuselage. Also, the reciprocating engine requires large volumes of cooling air that must be forced around cylinders of air-cooled engines or through radiators of liquid-cooled engines and through accessories and oil coolers Figs. 10 and 11 show power losses at different speeds for a typical 2,000 hp engine installation complete with propeller and installed in a wing nacelle. Remaining available power under any but low speed flight conditions is greatly reduced by these losses Fig 10 shows typical losses for maximum engine power at all speeds, and Fig. 11 shows average losses for the same engine under flight conditions in a large airplane with a top speed of 400 mph Higher speeds would still further accentuate the losses. Also shown in Fig. 11 is a fuel rate curve based on net thp of the power plant after all of its losses have been accounted for; this should be compared with the excellent performance of similar engines on the basis of shaft hp output, shown in Fig 3.

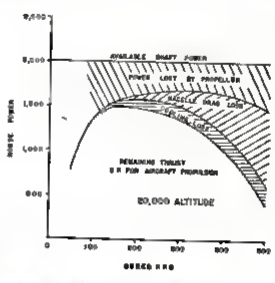


Fig 10 Typical losses associated with large reciprocating engine in wing nacelle and operated at full power.

Large reductions have been made in propeller losses in recent years, and also in nacelle and cooling drags, which may be attributed principally to nacelle design improvements and the use of engine cooling fans on radial engines It is reasonable to suppose that further reductions will be made in the future—particularly for specialized applications such as high altitude, high speed flight. Until such improvements are made, high speed operations will be limited by power plant rather than airframe whenever reciprocating engines are used.

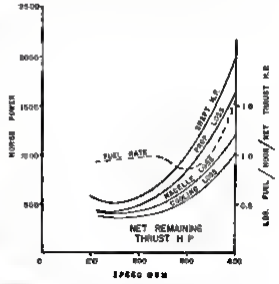


Fig 11. Typical flight losses of power plant of Fig. 10, when operated on the power-required curve of large plane designed for long-range operations.

Jet Plane Compared

The axial flow jet engine (Fig 4) is a slender unit capable of delivering almost constant thrust at all speeds

(*Turn to page 247*)

These Connection Techniques Solve Aluminum Cable Problems

By **JULIAN ROGOFF**, *Assistant Chief Engineer, Burndy Engineering Co*

Here's a comprehensive discussion of the obstacles encountered in effecting dependable, low-resistance hookups with aluminum cable, and how surface treatment of aluminum connectors and proper installation practice can overcome these difficulties.

USE OF ALUMINUM CABLE for electrical wiring in aircraft presents the decided advantage of definite weight saving, but several disadvantages have delayed the wide-spread adoption of this conductor. Foremost is the difficulty of making reliable, permanent, low-resistance connections —especially to copper buses, studs, or nuts.

For some years, Burndy Engineering Co. has been studying this problem, and the methods which we now believe offer the best solution are presented here.

Conventional methods of making connections as used by power-and-light companies were not found to be applicable to aircraft wiring. Connectors used by utilities consisted of relatively large devices with large contact surfaces, and conductors were either rigid or were cables with a small number of relatively large strands. Contact surfaces of both connectors and conductors could be cleaned carefully by scratch-brushing or emery cloth while protected by a film of petrolatum or other grease, and the assembly of connector and conductor could be made with protective grease still in place.

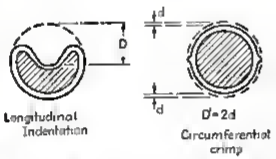


Fig. 1. Typical cross-sections of longitudinal indentation and circumferential crimp. (D) and (D') represent total indentation, not necessarily equal for both types.

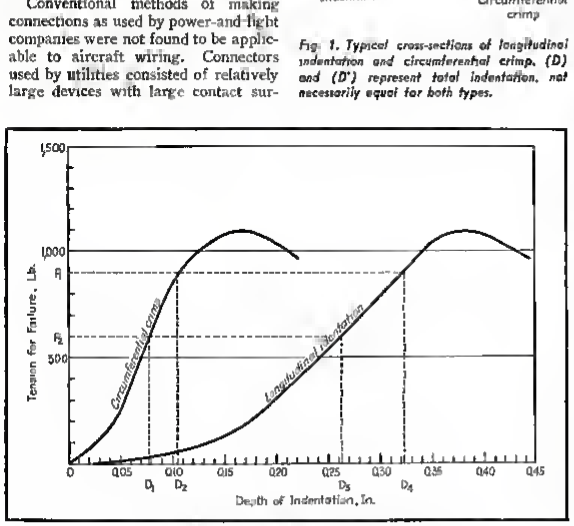


Fig. 2. Comparison of indentation methods on pullout tension of No. 2/0 aluminum cable installed in aluminum terminals.

Aircraft wiring requires aluminum cable with a large number of small strands and calls for electrical connectors which are small and light. The large number of small strands makes it a practical impossibility to clean oxide off each individual strand under a protective film of grease. And the small size of the connectors required involves small areas of contact surface—making it more imperative that the contact between cable and connector be highly efficient.

Connections Pose Problems

Principal problem encountered in making connections to aluminum aircraft cable is elimination of the oxide film which forms on the strands with exposure to air. This oxide film is tough, adherent, of high electrical resistance, and affects the connection in two ways. First, it causes high contact resistance between the outer layer of strands and the contact surface on the inside of the connector barrel. Second, it causes high transverse resistance in the cable—from the more numerous inside strands to the outer layer from which the current must be picked up by the connector.

Although much research has been concerned with the effect of the oxide film on contact resistance, relatively little has been devoted to its effect on the transverse resistance within the cable. Investigation of this latter manifestation shows, however, that it is of very great importance in determining the over-all resistance of electrical connections with aluminum aircraft cable. The effect of methods for reducing transverse resistance will be discussed later herein.

Another problem causing difficulty in the use of aluminum aircraft cable is the effect of corrosion, which may be of two types: First, the progressive building up of oxides or salts at the contact surfaces of cable and connector, and second, the electro-chemical corrosion occuring where aluminum and copper are in contact. The first principally affects the connection between cable and terminal; the second affects the connection between terminal and the copper bus, stud, or nut which are generally part of the electrical equipment.

Because the principal method of connection with aluminum aircraft cable is by means of pressure applied either circumferentially or in the form of indentation, the effect of cold-flow on the aluminum strands compressed over a long period of time must be considered. Aluminum is highly malleable and may relax under sustained pressure unless that pressure is distributed over a sufficient area.

In addition to all these problems, others less difficult are also encountered and include the effect of vibration on the connection and on the cable strands located there. In addition, the connector must grip the cable sufficiently to give good values of pullout. The cross-section of the connector must be enough to provide low electrical resistance, when the problems of contact resistance and transverse resistance are adequately solved. The temperature rise of the connector carrying rated current, according to Navy Department specifications, should be no greater than 5 deg. C. (9 deg. F.) above that of the cable to which it is connected.

These factors in the design of connectors can be readily taken into account once the principal problems, previously described, are solved. In the following discussion, various considerations affecting the primary connection difficulties are described in detail.

Because of weight and space limitations in aircraft, the most practical way to connect aluminum cables is to use indented or compressed connectors. These connectors are much lighter and smaller than those which clamp the cable by screws, wedges, cones, or other mechanical means. Also, they are installed faster and are less expensive both in first cost and installed cost.

In present-day practice, two general types of indented or crimped connections are used—those installed by longitudinal indentation and those installed by circumferential crimp (Fig. 1). A careful examination of these two types of installation procedures, especially in regard to aluminum cable, is therefore important, and as an indication of the relative merits, pullout can be used as a measure of value.

Using identical connectors and cable for each test, a curve can be drawn by plotting values of pullout versus depth of indentation of the longitudinal punch, and similarly, a curve can be drawn by plotting values of pullout versus depth of indentation of the circumferential dies, for comparison.

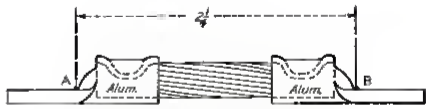


Fig. 3. Jumper assembly of aluminum Hylugs indented on No. 4 aluminum aircraft cable.

Fig. 2 illustrates typical curves obtained for circumferential crimps and longitudinal indentations. In each instance, the curve rises to a peak which may become substantially equal to the breaking strength of the cable and may then drop off as the indentation or crimp causes damage to the cable strands.

Pullout on portions of the curves to the left of the peaks usually results in a slip of the cable in the connector, whereas pullout on that portion to the right of the peaks usually results in breakage of at least some of the cable strands. Hence, in selecting a correct pullout for maximum efficiency, a value somewhat below the peak should be chosen so that no chance of damage to strands exists. This value is shown as P_1 in Fig. 2.

Indentation Methods Compared

Because of tolerances inherent in the terminals, cables, and installation tools, as well as wear of the latter, a minimum value of pullout should also be selected—shown as P_2. Thus, a cable connection properly made will have a minimum pullout of P_2 and maximum pullout of P_1. Reference to the curves in Fig. 2 shows that the depth of crimp or indentation required to obtain pullout values between P_1 and P_2 varies between D_1 and D_2 for the circumferential crimp and between D_3 and D_4 for the longitudinal indentation.

The difference between D_3 and D_4 is approximately three or four times that between D_1 and D_2, indicating that the permissible variation in depth to compensate for wear and tolerance is three to four times as great for the longitudinal indentation than for the circumferential crimp—an important advantage.

Fig. 1 indicates another important advantage of the longitudinal indentation over the circumferential crimp. As the longitudinal indentation is formed, the area of the terminal in contact with the strands actually increases, so that the final area in contact is approximately 10 percent greater than the original area. On the other hand, the circumferential crimp actually shrinks the amount of area in contact with the strands by approximately 20 percent. This is an especially important factor with aluminum cable, since the more strands that come into direct contact with the connector barrel, the less detrimental is the effect of transverse resistance within the cable.

As the longitudinal indentation is made, the strands are forced to shift and rearrange themselves, causing them to exert a wiping action on each other, thereby tending to clean off the oxide film. A circumferential crimp does not have this advantage—the strands being merely squeezed tighter in the same relative position.

Another advantage of the longitudinal indentation is the cup form of deep draw which coins the metal of the terminal into the metal of the cable and maintains its shape against relaxation of pressure and springback, because of its steep sidewalls. The circumferential crimp does not have the same structural strength or resistance to springback inherent in its shape.

A final advantage of the longitudinal indentation is the smaller amount of pressure required to make the indentation, thus permitting use of smaller, more convenient tools to install the terminals.

It is apparent that a longitudinal indentation presents definite and important advantages over a circumferential crimp for making connections to aluminum cable, and carefully controlled as to size and depth, it was therefore selected by our company engineers as standard. However, it is important to emphasize that our dies for installing connectors on copper cables are not suitable for installing aluminum connectors on aluminum cable, and that dies of dimensions especially designed for aluminum must be used.

Cable-to-Connector Tests

Electrical current passing from cable to connector travels from the inner strands of the cable through contact surfaces to the outer strands; thence it goes from outer strands through contact surfaces between them and the inner surface of the connector barrel, and into the barrel. Accordingly, contact resistance between cable and connector consists not only of the resistance between the strands and the connector, but also of the resistance between and through the strands.

This is particularly true of aluminum cable. Copper cable has very low

Measurement of Electrical Resistance for Assembly Shown in Fig. 3.

Alum. Cable Size	Terminal Catalog Number	Treatment of Terminal Contact Surface	Method of Using Compound Filler	Resistance in Microhms		Relative Conductivity Percent
				Distance A—B	Equal Length Cable	
No. 4	YAV4CA-L	None	None	136 41	81 74	59 8
No 4	YAV4CA LZ	Zinc-flashed	None	91 92	81 74	88 9
No. 4	YAV4CA-LZ	Zinc-flashed	Contact surface compound coated	78 75	81 74	103 8
No. 4	YAV4CA-LZ	Zinc-flashed	Compound forced between cable strands	69 57	81 74	117 3

resistance between strands and current passes from strand to strand even when pressure is not exerted on them. On the other hand, each strand of aluminum cable is covered by a film of aluminum oxide, which very largely insulates each strand from those adjacent, thereby causing the cable to act substantially as if it were made up of a series of parallel conductors. It is necessary that the cable connection (as distinguished from cable connector) break down the transverse resistance between strands to carry the current from the inner to the outer strands, from which it can be picked up by the connector.

Our company engineers have conducted many exhaustive tests on this problem and have finally concluded that the most effective method of breaking down the transverse resistance is by the introduction of a compound comprised of zinc dust suspended in petrolatum jelly.

This compound performs a triple function. First, it covers and protects the inner surface of the connector barrel after that surface has been treated to eliminate the oxide film, also it prevents new film from forming before the connector is installed on the cable. Second—and most important—when the cable is inserted into the barrel of the connector, the compound is restrained from pushing out of the barrel and is forced between the strands. Subsequently, when the connector is indented onto the cable end, the particles of metallic zinc, coating each strand, break through the film of oxide and thereby provide numerous low resistance current paths from strand to strand and from strand to connector. This effectively reduces transverse resistance between strands in the cable connection.

Third function of the compound is to inhibit and prevent the formation of oxides or other products of corrosion in the electrical connection after it has been made and is in actual service.

Before the zinc-petrolatum compound is inserted into the connector barrel, it is necessary to remove the film of oxide on the inner surface. This is accomplished by chemically etching the surface, and—with the surface still wet and protected from attack by atmospheric oxygen—immersing in a bath which precipitates a zinc-flash on the aluminum surface. The zinc-flashed surface is then plated with zinc to provide a mechanically strong coating.

The aluminum contact surface is thereby covered with a coating of low resistance metallic zinc that prevents formation of high resistance aluminum oxide. Thus the contact surface of the aluminum connector is provided with a surface of minimum contact resistance, in turn protected from the atmosphere by the zinc-petrolatum compound.

To demonstrate the effect of surface treatment and the use of zinc-petrolatum compound, a number of tests were performed in the laboratory. A group

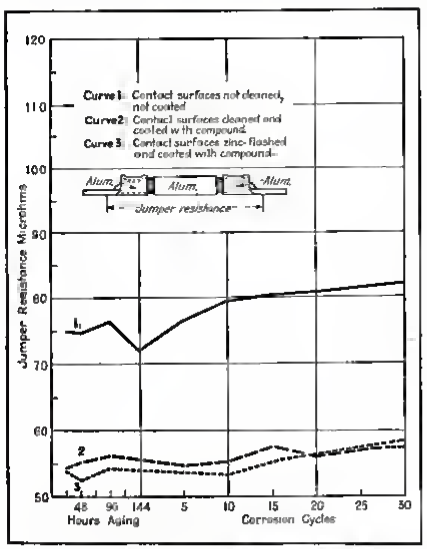


Fig. 4. Curves showing effect of corrosion on electrical resistance of connections between aluminum lugs and aluminum aircraft cable.

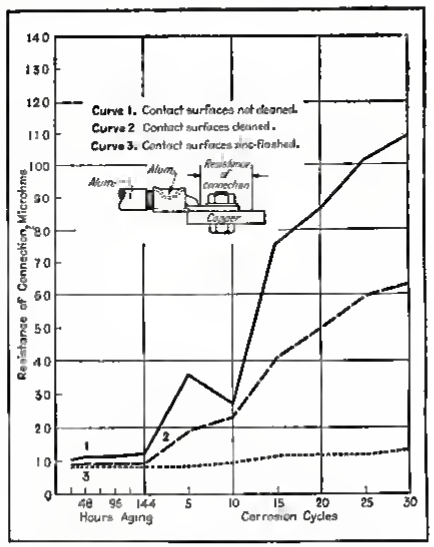


Fig. 5. Curves showing effect of corrosion on electrical resistance of connections between aluminum lugs and copper contact pads.

of aluminum terminals, each installed in different manner, were indented on the ends of short lengths of No. 4 aluminum aircraft cable to form jumpers, as illustrated in Fig. 3.

Measurements of electrical resistance were made for each assembly from points (A) to (B), and results are given in the accompanying table. Note the progressive improvement of electrical conductivity as each new modification in treatment and installation method is introduced.

The improvement can be attributed to these factors alone since all other variables, such as size and stranding of cable, size of terminal, depth of indentation, etc., were kept constant. Thus, starting with identical cable, terminals, and indentation, the electrical conductivity of the finished connection can be practically doubled by surface treatment and installation practice alone.

In addition to providing lower initial resistance, the zinc-petrolatum compound helps to inhibit corrosion of the cable connection. Fig. 4 shows a series of curves, wherein resistance of the electrical connection is plotted versus number of corrosion cycles. As indicated, the connections are allowed to age for 144 hr. before starting the corrosion test. Resistance measurements are made during this aging period to determine whether any appreciable relaxation of the metal takes place.

Each corrosion cycle consists of a 24 hr. period during which the samples under test are immersed in a fog of 10 percent brine solution for 7 hr., then heated at 125 deg. C. for 45 min., and finally allowed to cool to room temperature for the remaining time. From Fig. 4 it can be seen that the increase in resistance as a result of exposure to 30 corrosion cycles is relatively small in terminal connections with zinc-petrolatum compound fillers.

Connector-to-Bus Data

Most electrical connections consist of terminal attachments, and almost invariably the tongue of the terminal is clamped to a plated or unplated copper bus, nut, or stud. Therefore, when aluminum cable is brought into an aluminum terminal, provision must be made to inhibit electro-chemical corrosion between the aluminum terminal tongue or pad and the copper part to which it is attached. This may be accomplished in three ways:

(1) By covering the contact between the aluminum and copper parts with heavy grease, paint, or other sealing compound to prevent penetration of an electrolyte (such as salt moisture, etc.) to the contact.

(2) By introducing a bimetal washer—aluminum on one face and copper on the other—between the dissimilar metals, so that like metals are in contact.

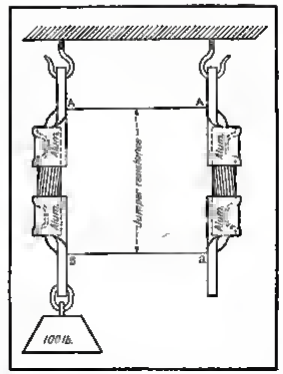


Fig. 6. Jumper assemblies of aluminum lugs installed on No. 2/0 aluminum aircraft cable for cold-flow test.

(3) By plating the contact surfaces—preferably the aluminum surface—with a metal which will retard electro-chemical action between the aluminum and copper.

The first of these methods may be effective for the period immediately after installation. However, paints or greases are subject to wear and erosion, and as soon as the coating is penetrated, electrolytic corrosion may start. Also, electrical connections in aircraft are subject to change or disconnection, and mechanics in the field cannot be relied upon to replace the protective coating with each reconnection.

The second method has proved to be very effective. However, the bimetal washer is a loose part that may not be replaced or possibly may not be assembled on the original installation.

The third method—plating the aluminum contact tongue with copper or zinc—does not have any of the disadvantages mentioned, and also effectively inhibits electrolytic corrosion. Reference to Fig. 5 shows that the electrical resistance between zinc-plated aluminum terminal tongues attached to copper contact pads, changed remarkably little when exposed to the corrosion test previously described. In contrast, bare aluminum terminal tongues attached to copper pads showed an immediate marked increase in resistance when subjected to the corrosion test, indicating the deteriorating effect of electrolytic corrosion between the two metals.

It is especially notable that tests show that zinc plated aluminum parts in contact with copper compare very favorably in corrosion resistance with copperplated aluminum parts in contact with copper.

Since zinc plating of aluminum connectors also performs the function of protecting the contact between the aluminum connector and the aluminum cable, it is obvious that a zinc plated aluminum connector is more advantageous than one with a copper plated tongue. An additional advantage is that zinc plated terminals are effective in making trouble-free connections to steel or cadmium plated steel parts as well as to aluminum parts. And finally, zinc plating of aluminum terminals is more economical than copper plating. For these reasons, our company has

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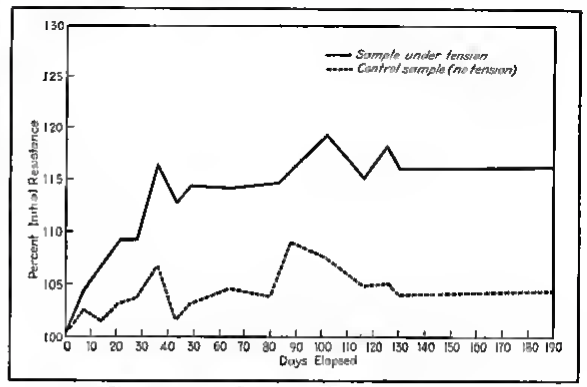


Fig. 7. Effect of cold-flow on electrical resistance of connections between aluminum lugs and aluminum aircraft cable.

Induction Heating Speeds Helldiver Production

By E. K. FRY, *Assistant Superintendent Curtiss-Wright Columbus Plant*

Here are details of a processing method which has "done the trick" on numerous brazing, production, and salvage jobs—to improve quality and expedite output of small parts for C-W Helldivers.

INDUCTION HEATING is saving thousands of hours of production time in building Curtiss Helldivers. The process handles at least 75 tool brazing jobs, 10 production jobs, and dozens of salvage items. It is in operation six days a week, and its use in more jobs is planned.

Our machine, manufactured by the Thermonic Induction Heating Corp., has a specially designed four-outlet table for different coils. This type of machine is much more flexible than a single-outlet machine, and it is more economical because of a minimum power loss.

Inductor coils are cooled by distilled water recirculated through a Bell & Gossett cooler. Use of distilled water is important where impure water would cause build-up in the tubes and possible short-circuiting, for the machine at this plant has an output of over 300,000 cycles.

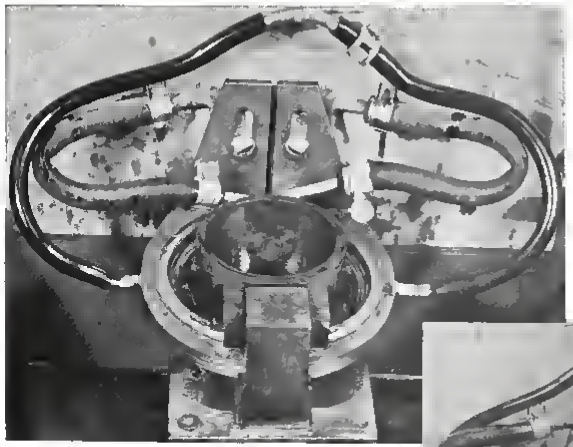


Fig. 1. Tail wheel cam in place ready for hardening. Outer hose handles quenching oil and inner hose circulates distilled cooling water through coil.

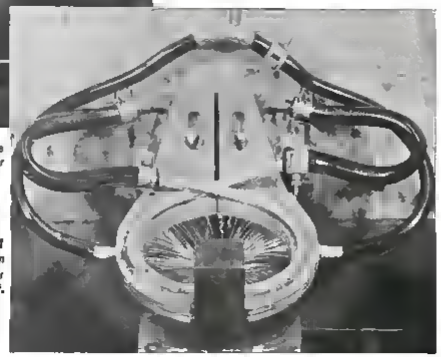


Fig. 2. Fixture shown in Fig. 1 with cam removed to show action of cooling oil spray. Slots at rear are for adjusting coil height.

First experimental job was the processing of case hardening lock pins for the Helldiver bomb bay. Previously the lock pin had been chrome plated, but induction heating made a better and cheaper job and cut the casing time down from 6 hr. to 10-15 sec.

It was necessary to use a steel capable of attaining 180,000 psi. and having high impact and fatigue values. Either SAE 4140 or NE 8739 fitted the job, although additional hardening was found necessary to cut down wear. Chrome plating helped, but was not satisfactory where impact was heavy. After .0005 to .001 in. of chrome was applied, the pin had to bake at 400 deg. F. for 3 hr. to relieve hydrogen embrittlement.

When we tried induction heating on the lock pin, the piece was first preheat-treated to 180,000 psi. and finished except for polishing. The outer surface of the pin was then induction-heated to approximately 1,625 deg. F. and quenched in water. Test samples proved that a case .020 to .030 deep could be attained with a Rockwell C58-C62 reading. This was sufficient to withstand the necessary wear, while still retaining a 180,000 psi. core.

Case hardening of a tail wheel cam (it had formerly been carburized) also proved very successful by cutting processing time 50 percent. The cam, designed for a 150,000-psi. load, had a thin section approximately .170 thick by 1 in. wide. It needed a hard surface in order to withstand roller action against this thin section.

To harden the thin section properly, we had to quench the work immediately. Usual quenching fixtures would not work, because the oil spray came from a quenching ring located outside the inductor coil and at least 1½ in. from the surface to be hardened, too distant to give a quick quench.

Accordingly, we made a spray quench of ½ in. copper plate, contoured to fit not over .040 in. from the cam surface at any point. Then an inductor coil of ¼ in. copper tubing was fitted to the top of the quenching plate.

The assembly was connected to a pump built into a water-tight tank, with the holding fixture set in the middle of the tank under the inductor coil. The pump was connected by a secondary timer to the timer on the induction machine.

The cam is preheat-treated to 150,000 psi., finish machined, and ground. Then it is placed in the induction machine and heated to 1,625 deg. F. After about 20 sec., the timer shuts off and the pump quenches the cam in oil, with a resulting hardness of C55-C60 and a core of C32-C36. Figs. 1 and 2 show the induction heating and quenching of the cam.

One of the best examples of the method is the Helldiver blast tube shown in Fig. 3. Here a preformed tube and a collar of 18-8 stainless steel are welded with columbian bearing rod, after which the assembly must be normalized to stabilize the weld.

Before the use of induction heating, this procedure was performed at 1,950 deg. F. in an electric furnace, after which the tubes were quenched in cold water. This caused distortion, which necessitated from 15 to 30 min. line-up time on each tube.

To eliminate this line-up operation, we designed an inside induction coil over which the tube could be slipped so that the coil would normalize the welded area only, and would thus avoid heating the adjoining metal into the brittle range occurring around 1,400-1,500 deg. F.

It was necessary to have a very close fitting coil not more than $\frac{1}{16}$ in. from the inside wall of the tube, so that the fastest possible heating could be had. It seemed impossible to make a fixture which would keep each tube exactly the right distance from the coil as it was being heated. Because of this necessity to be so close to the coil for correct heating, the tube would accidentally short the inductor coil and burn it out. We tried commercially insulated coils, but they broke down, so we ourselves experimented with coating of the coils.

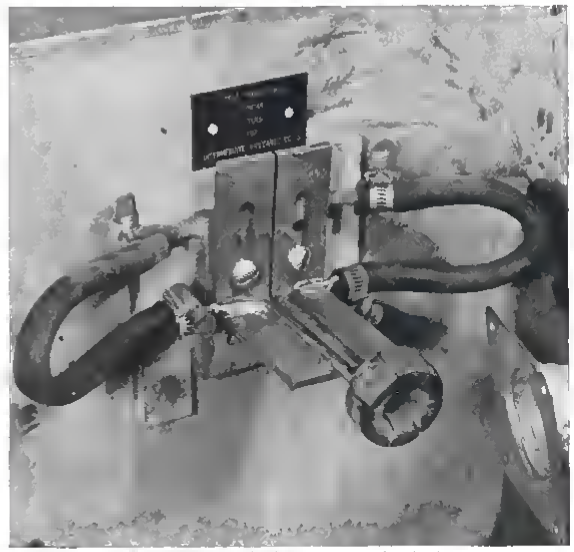


Fig. 3. Showing coated inductor coil (center) with tube to be heated (right). Tube is slipped over coil for heating.

Fig. 4. Standard two-turn inductor coil with cutter in place for brazing carbide tip.

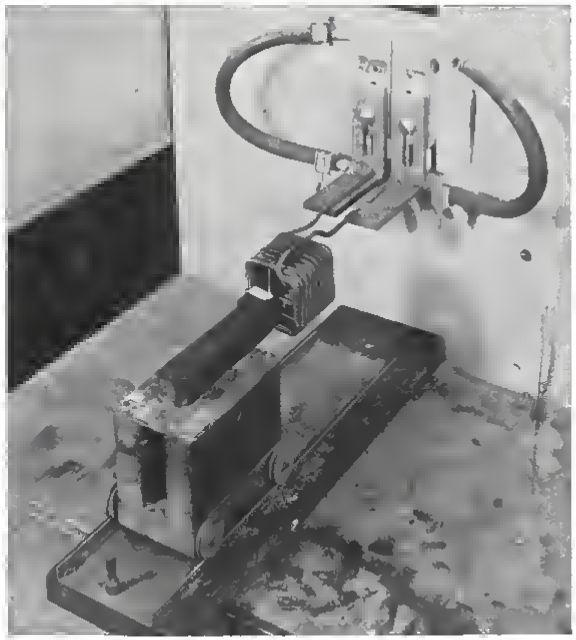


Fig. 5. Multiple-turn inductor coil for welding carbide tip on tool. Tool is wheeled forward on small truck.

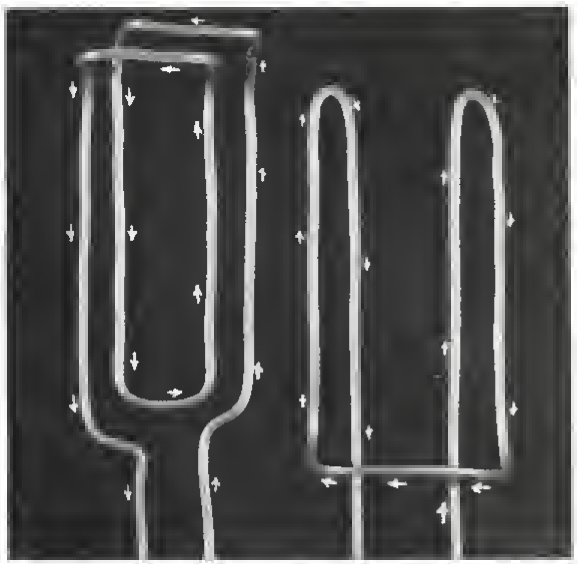


Fig. 6. Correct (right) and incorrect (left) methods of bonding inductor coils. In coil at right, current reverses itself, causing impedance and loss of efficiency due to reverse parallel flow.

A coil was formed whose circumference measured $\frac{1}{8}$ in. less than the inside circumference of the blast tube. We mixed powdered mica with just enough sodium silicate to hold it together, then we molded the compound around the copper tubing of the coil and baked it until dry.

With these coated coils, it is possible to dispense with a fixture altogether. The operator merely holds the tube and forces the end over the coil, heating the weld to 1,950 deg. F. in 14 sec. Then he removes the tube and dips the heated end in cold water to quench—all in a matter of seconds. No line-up operation is necessary.

Later we tried another coating which proved to stand up even better than the mica. Standard asbestos rope (string asbestos mixed with fire clay) was pulled apart, kneaded until pliable, and packed around the coils.

Our early coated coils sometimes cracked after a few hours, so before the coil was baked, we cut into the soft coating with a knife, making grooves which gave plenty of allowance for expansion. We also dried the coated coils more slowly, leaving them in an oven for 4 hr. at 360 to 400 deg. F. Some of these new coils have a life of 20 hr. or more. One coil has heated 800 blast tubes, and it is still in good condition.

Frequently, in reworking tools, the induction machine has proven superior to a torch for localized annealing, due to the speed of heating which confines the heat to a smaller area and often makes reheat-treatment unnecessary.

Fig. 4 shows the right and wrong way to design a double turn coil. The inductor coil on the right reverses itself, causing an interruption in the current flow. This type coil will not heat properly due to impedance. The coil on the left has a minimum of impedance with the current flowing in the same general direction.

To solder or braze tools, best results are obtained when the heat is allowed to travel by conduction from behind or under the shank to the bonding material and tip. Figs. 5 and 6 show coils which are standard for tipping tools. At the present time, one semi-skilled operator can braze several hundred tips per day. Thus, skilled welders, who formerly did this job, are released for urgent production duties.

We have a simple quick-change adapter and hose connection, Fig. 7

TRIMMING RESEARCH TO THE POSTWAR POCKETBOOK

PART VI OF A SERIES

"In the laboratory, as in the plant, we must record the volume of work that is to be done and the rate and cost at which it is completed."—Management Maxim

By **K. R. JACKMAN**, *Chief Test Engineer, Consolidated Vultee Aircraft Corp., San Diego*

Challengieg questian as peacetime loams is, "How much of grass iecame should ga for research?" Ta be considered as an amaunt levested, rather thae spent, the author then emphasizes the impartaet rale af the budget as a guide tar aperotions. And after namiag specific budget figures, he discusses the approach ta efficient cast accaueting and operatianal control systems.

BY RESEARCH TODAY we can assure prosperity tomorrow. With the postwar world "just around the corner" we can, by immediate proper planning and investment in research, make possible the production of new goods, new services, new industries, and new jobs a few months hence.

Regarding those companies now supporting research or development laboratories doing government work, one thing is obvious. If they are not today seriously considering reorganization of their laboratories for the best possible postwar economy, they will certainly do so in a few months, when the curtailment of Army and Navy contracts will force them to spend their own capital assets.

Accordingly, a short discussion of the economy of laboratories and their financial problems is in order, with primary consideration of aircraft research organizations but with many of the studied conclusions based on developments by older research organizations in other industries.

How Much for Research?

Dr. Karl T. Compton,[VI-1] president of MIT and recently chairman of the Advisory Committee on Scientific Research of the National Assn. of Manufacturers, several years ago stressed the fact that income appropriated to research is not spent; it is invested. "The question is not whether a company can afford to engage in research," emphasized Dr. Compton, "but whether it can afford not to, particularly when it is realized that after this emergency has passed, orders for the normal consumer market must be found to replace government orders. This market can be created only by new and better products."

COMPARATIVE RESEARCH EXPENDITURES 1927 AND 1938 AS PERCENTAGES OF DOLLAR VALUE OF OUTPUT

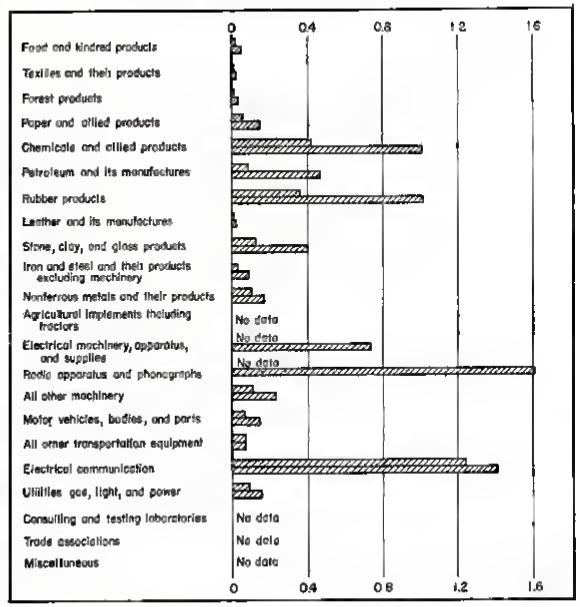


Fig. 1. Here, paired bars—upper 1927, lower 1938—indicate growth of research activities in various industries over a decade just prior to World War II. In this graph expenditures for research have been gaged as percentages of total dollar value of products. (From "Research—A National Resource," NRPB.)

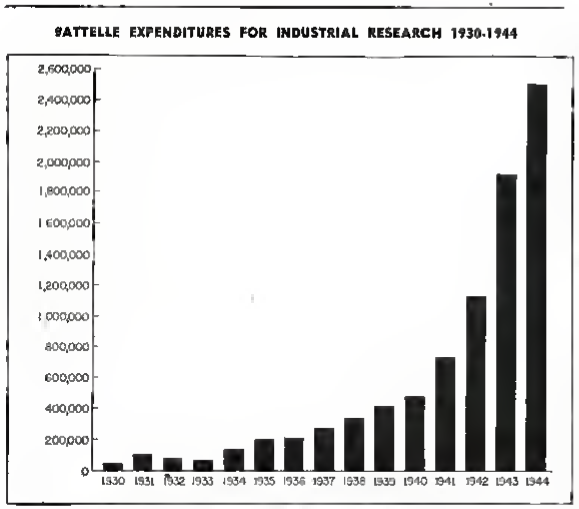


Fig. 2. Evidence of Battelle Memorial Institute's progressive research service to industry is this graph showing striking climb of yearly budgets since bottom-scraping days of the depression. (Battelle illustration)

Industrial research was well developed in Europe before its general adoption in America, but the U S now leads in total spent on research and, except possibly for the Soviet Union, in the ratio of research expenditures to national income Satisfactory figures are not available, but Bernal[II-8] has estimated that we spend more on research than all the rest of the world other than the Soviet Union, and that England and Germany spend possibly a tenth as much, France and Italy appreciably less[III-6] That is, prewar.

Excellent and extensive laboratories are found in Soviet Russia Japan also developed first-class facilities Each of the smaller industrial countries provides for research Switzerland, for example, makes up in quality for part of its lack in quantity Research is generally recognized as a factor in international as well as in national industrial competition and development.

As mentioned in a previous part of this series there were, according to the last prewar census of research laboratories in the U. S made by the National Research Council, almost 2,400 industrial laboratories, employing more than 70,000 persons in technical research Studies by the Council indicated that about $4,000 is spent annually for each person engaged in industrial research, and that those companies having laboratories spent approximately $300 million a year for industrial research just prior to this war.

This figure has undoubtedly doubled and trebled in the last few years under the government's emergency expenditures, but it appears quite probable that the immediate postwar appropriations for research in industry will better the $500 million a year mark.

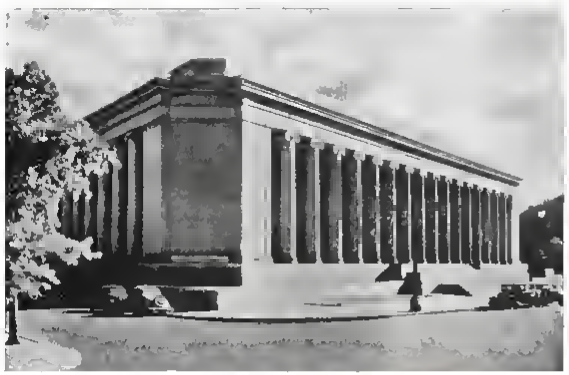
In 1941 the National Assn of Manufacturers completed a survey of research budgets of manufacturing companies[VI-2] and found that, of the 181 reporting, about 8 percent of all that are known to have laboratories spend in the course of a normal year 2 percent of the gross sales income of the companies involved in research.

Many of the companies reporting in this 1941 survey spent 10 percent or more of their gross sales income for research The 2 percent figure is the median for the 181 companies studied The figure was highest in small companies In the breakdown of the figures by industries, it was found that the chemical and allied products industries reported the highest expenditures The median figure was 4 percent of gross sales income for 28 chemical and allied products companies Further perspective is offered by the data in Fig 1 giving 1927–1938 comparisons for various industries

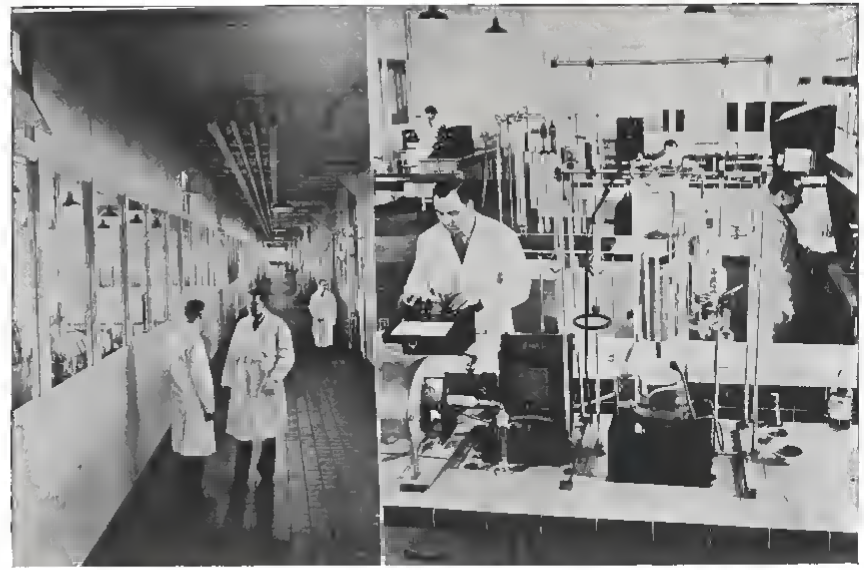
Dr Compton has pointed out that if all American industry spent 2 percent of gross sales income for research, there could be mobilized in America 250,000 scientists and engineers and $1,000,000,000 a year for the development of new goods, new services, new industries, new jobs, and new sources of wages and salaries

A survey by the National Research Council shows that in 1937 there were 125 trade associations in the United States engaged in various types of research activities Many of these associations have their own laboratories with trained scientists who devote their full time to problems of the specific industries served by the associations

In the 1941 survey, it was found that



Administration and operation of Mellon Institute exemplifies efficient budgeting of research One of most architecturally impressive structures in U. S. industrial research houses Institute (Mellon photo)



Buildings and equipment are primary budget considerations. Laboratory facilities, test equipment, and layouts at Chrysler (above) show careful attention to these important factors. (Chrysler photos)

research activities were conducted by 35 out of 113 manufacturing trade associations affiliated with the NAM in the National Research Council Eleven of them had their own laboratories or cooperated with others in supporting laboratories The average annual research budget of 27 associations reporting specific figures was $36,960 per laboratory The median budget was $25,000 Two associations spent more than $100,000 a year Twenty-one of the associations financed research projects for their members at universities, seven at research foundations, and three at commercial laboratories

Further Figures

In the Armour Research Foundation[VI-4] in Chicago the appropriations and contributions for the carrying on of research projects have increased from $30,000 in 1936, the first year of the Foundation's existence, to $1,670,000 in 1944 The "searchlights" which the Armour plan is prepared to focus upon industry's research problems represent the coordinated resources from the four broad fields of scientific endeavor—chemistry, physics, metallurgy, and research engineering.

Founded to conduct research for industry on a non-profit basis, the Battelle Memorial Institute[VI-5] began operations in 1929 just as the great industrial boom of the late '20's was coming to an end Throughout the ensuing world-wide depression, the recovery of the '30's, and the violence of World War II, Battelle has continued to grow The staff, originally 30, now numbers 600, and the Institute today is known and respected throughout the world of research and engineering The 1930–1944 growth of Battelle's service to industry is depicted, budgetwise, in Fig 2

In the first five years of the Mellon Institute at Pittsburgh, (1911–1916), 105 one-year fellowships were supported by 47 concerns, the total amount contributed being $360,000 During this period the Institute itself expended $175,000 in overhead charges, and the building and equipment represented an investment of over $300,000 By the application of the Industrial Fellowship System, the Institute has been successful in demonstrating to American manufacturers, irrespective of size, that industrial research, properly carried out, is profitable to them Most of the problems accepted for study have been solved satisfactorily In 1936, the amounts contributed to the Institute by Fellowship donors for support of research reached the sum of $1,000,000 annually The money appropriated by donors during the first 25 yr, (up to 1936) was close to $11,000,000.[I-3]

Factors Affecting Ratio

R. Stevens,[III-8] director of the Survey of Research in Industry group, points out that no standard practice has been found for the determination of the amount to be spent by a company on research Some companies attempt to establish a relation between expected value and the budget, a basis requiring rather clearly defined objectives A few set aside a percentage of gross sales, while most use a combination of methods. A general ratio cannot be determined, since it varies with the nature of the product, the value added by manufacture, size of company, and many other factors. Inquiry in a variety of industries has shown, however, that ratios amounting to from ½ to 3 percent of gross sales are frequently found where research is well established

The principal expense in research laboratories is in wages and salaries, occasionally of the order of 75 or more percent For the purpose of estimating amounts spent by industry on

research, a figure of $5,000 per man per year has been used frequently by well-informed research executives. Although an average annual cost per man (professional and non-professional) of laboratory personnel of approximately $4,000 to $5,000 is considered reliable (as previously stated) in estimating the total amount spent by industry on industrial research, the average annual cost per person in any one company may vary widely—from $2,500 to over $9,000.

There is a lower limit for the average size company that maintains a large organized research staff. Assuming 2 percent of gross income as proper for research, then $20,000 is a reasonable budget figure for a company whose annual gross income is $1,000,000. This would mean a research staff of five people at an annual carrying cost approaching $4,000 per person. Obviously, large research staffs are not to be expected in the smaller companies, especially when postwar economy dictates the prevailing policies.

As in all the basic industries, the research by the iron and steel industry of the U. S. is carried out for the purpose of improving methods of manufacture and quality of products, reducing costs, developing new products, and determining new uses and new markets for old products.

Economical Research in Steel

During the period 1930 to 1940, the average expenditure for research by the U. S. iron and steel industry has varied between $8,000,000 and $10,000,000 per year—more than ten times the amount it was in 1925. Although the industry as a whole reduces its expenditures for research in depression years, the reduction is never proportional to reduced production. As a result, the relative number of research reports published increases greatly in depression years.

Frank T. Sisco,[VI-4] metallurgist, stated that the expenditure for iron and steel research in 1938 was only 8 percent lower than in 1937 despite a decrease of 60 percent in steel production. The money spent for research by 42 steel companies representing about 90 percent of the steel-making capacity of this country, was, according to a 1939 survey made by the American Iron & Steel Institute,[VI-4] distributed approximately as follows:

Project	*Percent*
Improving quality	33
Improving methods of manufacture and reducing cost	19
Developing new products	20
Developing new uses and markets	28
	100

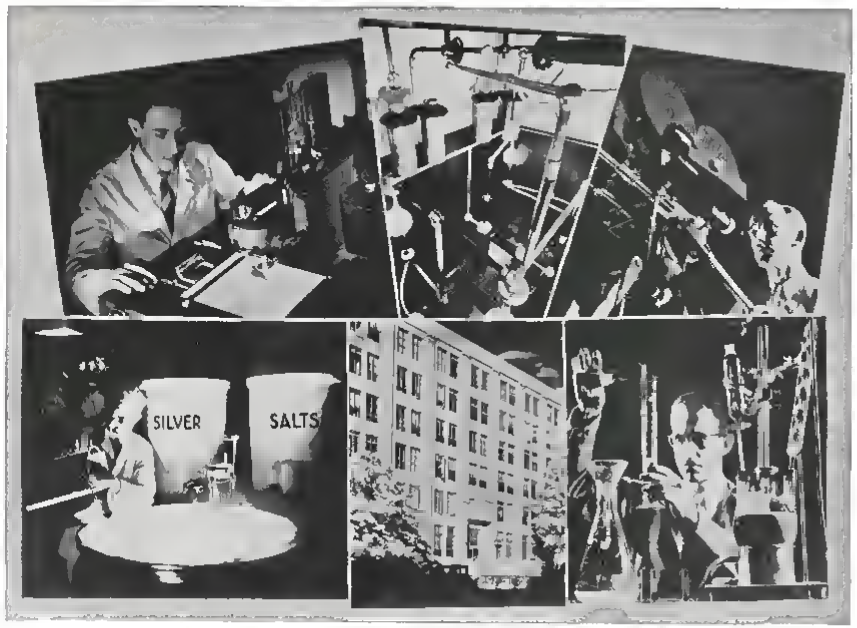
Seldom is a reader privileged to be taken into the confidence of a research director in the financial analysis of his laboratory. A zinc research laboratory, which may be taken as typical of laboratories for the metal-producing trades, was proposed by Dr. John Johnston[VI-9] during World War I. The fundamental work of this laboratory was to deal with the physical and mechanical properties of zinc, such as the study of its crystalline transformations, the temperature of inversion, and the effect of impurities upon these changes. This work would then be extended into a systematic study of the zinc alloys, through a wide range of conditions.

Metallurgical Research Costs

The laboratory work proposed was estimated by Dr. Johnston as requiring approximately 15 men distributed as follows in occupations and salaries:

Director	$10,000
Four men (1st class physical chemist, 1st class analytical chemist, 1st class metallographist, and testing machine operator)	15,000
Six assistants	12,000
Mechanics	2,000
Clerical, janitor, etc.	4,000
Total	$43,000

Necessary initial equipment would cost $25,000, but a further sum of $25,000 would have to be set aside for additions to the equipment within the first few years. Including the necessary overhead and operation costs, this laboratory would thus cost about $80,000 per annum. A suitable building to house this type of industrial research would cost approximately $100,000.[VI-4]



Budgets are specifically keyed to integrate the right personnel with the right facilities. Notable successes in research have thus been achieved in Eastman Kodak's laboratory (above) at Rochester, N. Y. (Eastman photos)

Budgeting Aviation Research And Development

Quite unlike the research progress in the iron and steel, the automotive, and several other basic industries in this country, the early developments in the aviation industry were not sponsored by individual company research but rather derived from research largely controlled by the government. Research conducted at government expense, has supplied the industry with general information from which the industry's own applied research has developed improved aircraft.

Competition for superior performance has tended to concentrate the manufacture of airplanes and engines in the hands of a few large concerns that maintain outstandingly able engineering and research organizations. The impetus of the present emergency has necessitated advanced engineering designs and production quotas, undreamed of several years ago, which in turn have necessitated larger and more efficient research laboratories.

J. C. Hunsaker, in an able article,[VI-5] states that from the first, the best scientific brains throughout the world have helped perfect the airplane.

The beginning of organized aeronautical research was the formation in 1909 in England of an advisory body, the Committee for Aeronautics, under the great physicist, Lord Rayleigh. Government research laboratories were later established in France, Germany, Italy, and in the United States.

Advances in airplane performance and utility have, somewhat discontinuously, followed—new knowledge in aerodynamics, metallurgy, structural design, fuel technology, and engine and propeller design. The steps are sometimes abrupt as inventions or applications occur, such as the NACA cowl and wing-engine location, the variable-pitch propeller, high-octane aviation gasoline, and now turbine and jet propulsion.

DISTRIBUTION OF GENERAL MOTORS TEST LABORATORIES

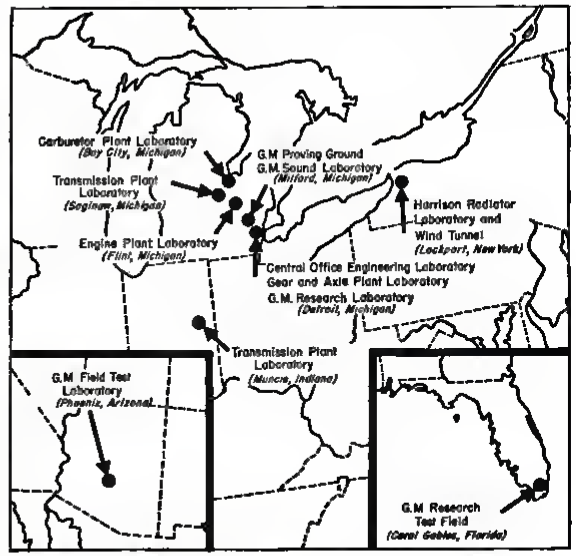


Fig. 3. Decentralized research sometimes makes for budget economy, as illustrated by GM's location of laboratory facilities at branches as well as at home plant. Test sites were carefully selected to be near primary users. (GM Research chart)

The government leads—and to a large degree coordinates—research in the aviation industry through agencies of the Army, Navy, and the NACA. The NACA Committee receives annual appropriations from the Congress "to supervise and direct the scientific study of the problems of flight, with a view to their practical solution." The increase of the annual appropriation for the NACA Committee, now summing to a total of over $20,000,000 for aviation research in the period 1915–1940, reflects the unparalleled rapid progress of this industry. Here are figures for general research:

5 Yr Period	Purposes	Construction	Totals
1915–19	$283,015	$131,500	$414,515
1920–24	1,061,150	46,450	1,107,600
1925–29	2,535,555	150,215	2,685,770
1930–34	4,306,320	1,445,944	5,752,264
1935–39	6,002,480	2,368,300	8,400,780

In 1938, Germany's aeronautical research facilities were large enough to contain a dozen establishments equal to the combined facilities of the NACA at Langley Field, of Wright Field, and of the Naval Aircraft Factory. However, with the grueling Allied bombings, it is hardly probable that many of these institutions and facilities still exist.

Hunsaker[VI-5] points out that the sound economic progress of prewar aviation and research in this country may be judged by the downward trend of domestic airline rates charged for services rendered between the years 1926 and 1939. During this period, the airline passenger fares dropped from 12 to 5c. a mile, while the rates paid by the Post Office for the carriage of airmail dropped 75 percent.

It is often stated that industrial laboratories must select research projects which will pay financially, whereas basic or "pure" research laboratories are not under any such limitation. But viewed with a truer perspective, as Dr. Steinmetz[VI-7] pointed out as early as 1916, this is really no limitation at all, since "there is no scientific investigation, however remote from industrial requirements, which might not possibly lead to industrial useful developments."

The present increased interest in the planning and controlling of postwar research and testing laboratories has induced various studies of industrial research procedures. Moreover,

this interest has led in not a few instances to the installation of budget systems whereby financial requirements can be predetermined with satisfactory accuracy. The first experience with budgetary practice was almost painful to research directors who had no knowledge of the science of management. But according to the observations of G. D. Beal,[1-3] assistant director of the Mellon Institute of Industrial Research, budgets have rather quickly become the guides for the operation of a number of large industrial research laboratories.

In many aviation companies, it is true, the administration of research and development is still a rather hit and miss affair. The writer trusts that the recent three sections of this series on administration faults and virtues have emphasized this fact. If a department of some company, let us say, desires the laboratory to make an investigation, its request is submitted to a conference committee, a decision is made as to the merit thereof, and authority is then given or withheld. Sufficient thought is not given to the costs of the project or to the necessary instrumentation.

In the more progressive company, however, a definite organization setup is established to plan all research laboratory activities and to control research expense.[1-3] The laboratory thus has a clearly defined program for the year, can plan its personnel, and can work accordingly. This systematic planning gives the basis for establishing an expense budget, and experience has shown that, if the latter is controlled, satisfactory progress is made toward controlling the cost of research, to the joint benefit of management, technology, and science. (Also see Fig. 3.)

Problems of Budgetary Control

To the young aviation laboratories, as to many of the oldline research organizations in the basic industries, there frequently comes the question, "What is the most adequate accounting system to use for crediting the research, development, and service testing accomplishments of a laboratory?" To this question no specific answer can be given, for the financial control procedures will be governed by the individual company's policy, the experience of the research director and his staff, the size of the research facilities, etc. Suffice it to say that research expense can be reduced only partially to a method of accounting, since the intangible and more remote results of many research projects are undoubtedly more valuable than the tangible and immediate values.

It is therefore wise to consider the positive savings, classifiable as tangibles, that are derived from novel or improved processes, reduction or disposal of wastes, sale or licensing of patented inventions, etc. The remainder of research expense—that relating to such intangibles as maintenance of quality through control, better products, and new products—is most sensibly charged off to product and market improvements.

Need for Careful Tally

Entering the stiff postwar competition just ahead, the aviation company management which is doing its share of original and practical research and testing should know the cost of keeping abreast of the times and should have a laboratory cost system, both for engineering and shop work, that reveals the sum total of calculable research accomplishment and of wasted effort.

In several of our most researchful manufacturing concerns, from whom aviation may well take many lessons, the cost of research is charged off currently as an item in general operating cost. Appropriations are established for specific projects at the annual period of review, and actual costs (engineering and shop) are recorded against these projects as incurred. Projects that may arise during the year are taken care of by an emergency fund, set aside at the annual period and held available for such interim researches. In one well-known company this fund amounts to 15 percent of the total appropriation. A special extra appropriation is made if, at any time, this fund proves inadequate to support promising new investigations.[1-2]

Beal and Weidlein,[1-3] of the Mellon Institute, have pointed out that "the use of budgets or operating schedules, for the purpose of forecasting operating results, has become an outstanding feature of the application of the principles of scientific management in the administration of industrial research." It is now recognized by many authorities that budgetary control of a research department or laboratory is a most effective mechanism for accomplishing resultful coordination within the department and with other departments of the organization. This control, if adequate, surely reveals beneficial work and new opportunities, as well as management defects and weak divisions and personnel.

The writer has tried several cost accounting and operational control systems in the management of research and development testing in the San Diego engineering test laboratories of the Consolidated Vultee Aircraft Corp. Several of these systems have shown definite promise as the search proceeds for the "best" method for general aircraft laboratories, but each one has proven to have its faults. The specific form and routine now in use will be discussed in this series in a future article on laboratory paperwork and control.

In these days of rapidly changing conditions, scientific aviation laboratory management, which usually operates on a factual basis, is endeavoring to develop improvements in its operational techniques, so that an organization may be more quickly adjusted to meet economic changes. It is most important under these conditions that the development laboratories be alert, sensitive to change, and flexible in personnel, structure, and facilities. A flexible budget is a device that makes it easy to effect technical adjustments of this character whenever they are necessary.[1-3]

It should be emphasized, however, that budgetary or operational control cannot replace management. It is not the purpose of such economic control of aviation research to deprive a laboratory director of the essential freedom of action that insures progressive management. Budgetary control cannot be perfected rapidly; it requires time to make and use estimates of future plans properly.[1-3]

Even in the laboratory which is not operated under a budget system there is usually kept a careful record of the expenditures for salaries, supplies, insurance, etc.—all classified in detail—for exercising economy in the conduct of the work. It is fundamental that every laboratory manager and director should understand enough about accounting to know when an accountant is needed.[1-3]

References to Part VI

Note: For added convenience in this series of articles, two numerals are employed in each reference key, the first numeral indicating the part number in the series and the second numeral being the reference number. Thus, (I-4) means "Part I, Reference 4."

(VI-1) *2% For Research* by Dr. Karl T. Compton, booklet published by National Assn. of Manufacturers, Jan. 1941.

(VI-2) *Industrial Research Progress at the Armour Research Foundation 1943-1944*, from *Chemical and Engineering News*, American Chemical Society, Dec. 1944.

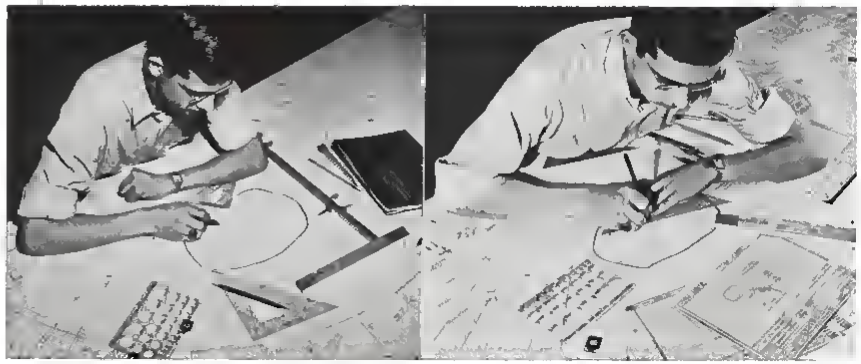
(VI-3) *Research in Action*, bulletin by Battelle Memorial Institute, Columbus, Ohio.

(VI-4) *Research in the Iron and Steel Industry* by P. T. Sisco, metallurgist and editor of *Alloys of Iron Research*, N. Y. C., Section III-3 of "*Research—A National Resource*". II *Industrial Research*, Dec. 1940.

(VI-5) *The Value of Co-Operative Research in the Development of the Zinc Industry* by John Johnston, Oct. 1918, reprinted from proceedings of American Zinc Institute.

(VI-6) *Research in Aeronautics* by J. C. Hunsaker, MIT, Section III-1 of *Research—A National Resource*, II *Industrial Research*, Dec. 1940.

(VI-7) *Scientific Research in Relation to the Industries* by C. P. Steinmetz, *Journal of the Franklin Institute*, Dec. 1916.



Deviation stickers are sent to company's subcontractors, who will superimpose them on photographically reproduced master drawings already in their hands. In first step of process (left) area to be changed on original master layout drawing is first circled, then original lines are erased. Next step (right) is to redraw area on Boeing's master drawing as specified by design change.

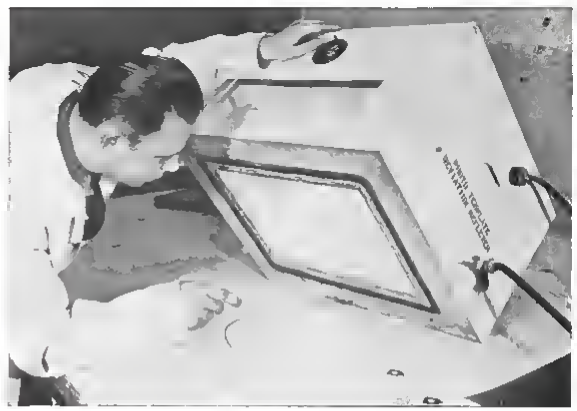
DEVIATION STICKERS QUICKEN TEMPLATE CHANGES

By utilizing steel shim photo patches, Boeing does away with necessity of supplying B-29 subcontractors with entire new photo template every time there's a design change. Shim stickers save time, critical materials, and shipping space.

MASS PRODUCTION of the latest versions of the B-29 Superfortress has been speeded by using an unusual design-change system developed by the Boeing Aircraft Co. of Seattle. This method makes use of photographically reproduced true scale shim stock patches known as deviation stickers.

At Boeing, all engineering and manufacturing information necessary for the fabrication of basic structures, cowling, ducting, and non-structural formed parts is drawn to exact scale on white lacquered steel sheets. Master drawings are photographically reproduced on steel as photo templates, required as patterns in the tooling, fabrication, and assembly of parts. And thousands of these photo templates have been sent to the company's five prime contractors and hundreds of subcontractors.

In providing initial information, this method proved very effective. However, when military and other requirements necessitated revisions on these



Parelyte plastic sheet, which has been sprayed with a sensitive emulsion, is placed over change-area on master drawing. Boeing developed deviation reflexer light box is then placed over plastic and exposure is made.

photo templates, problems were encountered.

Early in the B-29 program when a change occurred, an entirely new photo template was supplied to the Boeing shops and the various contractors. But as the program increased in size and urgency, it was necessary to have a fast, accurate method of supplying information to the widely scattered plants. In addition, there was a constant threat of an inadequate steel supply, since it takes a full railway carload of .038 steel sheet to produce a complete set of B-29 templates. Shipment of the templates themselves to the various contractors also presented a problem. And even though a change was slight, an entirely new template had to be produced and shipped, often with dependence upon slow and uncertain means of transportation.

In order to expedite and simplify the transmission of this change information, Boeing master layout engineers and photographers developed a process, now known as the deviation sticker system, by which accurate change information is photographically reproduced on lacquered shim stock only .003-in. thick.

In the first step in the process, the area on the master layout drawing affected by the change is erased and changed as required. This changed area is then photographically copied by the reflection printing process.

In a semi dark room a sheet of sensitized plastic is placed emulsion-face down against the changed area. A plywood box with a light source in the top and a plastic window in the base is placed over the sensitized plastic and a vacuum pump is turned on. A sponge rubber gasket around the edge of the plastic window makes a seal for the vacuum. Atmospheric pressure forces the window against the plastic negative material, which in turn is forced against the master layout, thus assuring a sharp, accurate reproduction.

A white light in the box illuminates the area covered by the plastic. The light passes through the sensitized material to the corrected layout and reflects this image back to the material. After exposure comes standard processing in a litho developer, and the negative is fixed and washed in the regular photographic manner. After the negative is dry, positive reproductions are printed on the .003 steel shim stock, which has earlier been sprayed with the same sensitive emulsion used on the negative material.

These steel shim reproductions are checked for legibility, trimmed to size with an ordinary scissors, then sent to the shops. Accurately lined up with the grid lines which are the background of every master layout drawing, the "stickers" are cemented to the existing photo templates.

This was the process, but there was still another hurdle, for unsatisfactory negative material discouraged early reproduction efforts. However, after several months of experimenting, successful reflex negatives were produced by spraying a reflex emulsion on .025-in. translucent plastic sheet. This emulsion had been made to Boeing specification by one of America's large photo supply houses. The plastic sheet, which is known as Paralyte, is dimensionally stable, translucent, and nonwater absorbent. Specially developed for this work, it is a combination of urea and melamine resins impregnated into an alpha cellulose base.

These sprayed type plastic negatives, found easier to handle in photo processing, recording, and filing, have further speeded the process of changing photo templates—another factor in putting more Boeing B-29 Superfortresses into the air in less time.

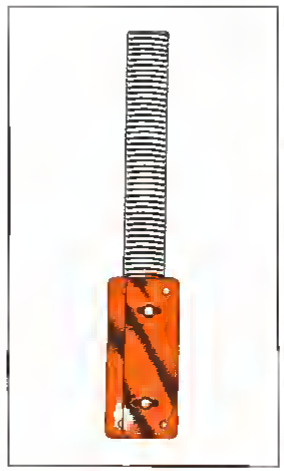
Paralyte sheet, which when developed becomes a negative, is used for making reproductions on .003-in. steel shim sheet, which has first been sensitized with same emulsion as used on plastic negative material.

Following developing process, shim sheets are trimmed and sent to Boeing shops and subcontractor plants, where they are cemented to all existing templates of a given drawing. This process obviates necessity of sending complete new template every time a design change is made.

PLANT-PRACTICE HIGHLIGHTS

Stretch-Wrap Method Speeds Door-Frame Output

• By making in halves and then joining by riveted splice plate, PBM bulkhead door frames are now fabricated at Glenn L. Martin in less than half time formerly required by old press-and-rout system. Besides cutting time, new method permits ten complete frames to be obtained from a sheet which formerly provided only four.

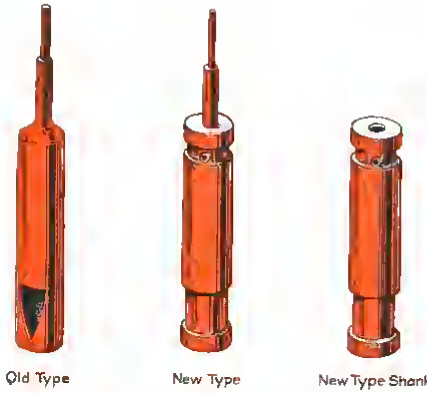


File Handle Prevents Injuries

• Handles which prevent files from slipping sidewise off edge of sheet metal have considerably reduced number of file injuries at Curtiss-Wright plants. Permitting full length of file to be used, handle may be set at any desired position.

Knockdown Engine Case Has Plywood Mount

• With use of a conical engine mount made of plywood joined with Uformite 500, a urea formaldehyde resin adhesive, P & W engines are now being shipped in knockdown cases which dispense with heavy timbers to which engine was formerly bolted. Developed by Resinous Products & Chemical Co., the adhesive enables ½-in. 3-ply birch or maple cones to support weight of 2,000-hp. engines, even when large holes have been punched in plywood.

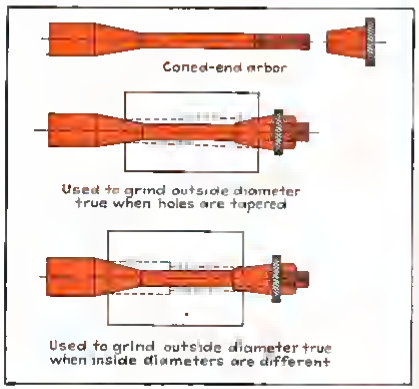


This Two Part Punch Conserves Tool Bodies

• Broken or worn punches formerly necessitated replacement of entire, one-piece tool, but at Westinghouse Sunbury plant great economies were made by using a detachable point, easily replaceable when necessary, without discarding still-useful punch body

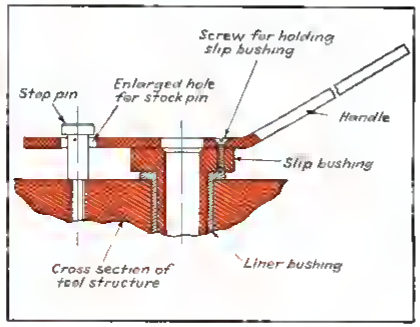
Special Arbor Assures Accurate Centering

• Made from hardened and ground steel, this arbor with coned ends has enabled General Electric to improve greatly the accuracy of ground work where outside surface must be concentric with internal hole within an extremely close tolerance. Taper of cones is 1½ in. per foot



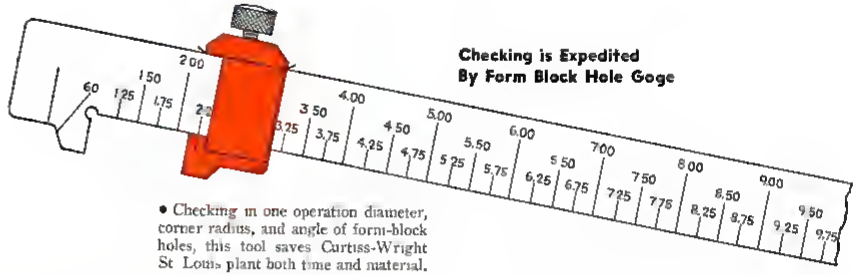
Simple Handle Aids Bushing Change

• In operations where several slip bushings must be changed while same work is in jig, this sheet metal handle has saved Convair much valuable time. Fastened to bushing by screw and prevented from turning by stop pin, device enables operator to change bushing simply by turning handle slightly, then lifting bushing out of hole



Collet Saves Broken Drills

• Drill points are saved for additional useful life by this collet, which drives by means of a hardened pin engaged with notch in broken drill. Collet (left) has threaded end to fit drill. Body has hex for wrench. Collet lock nut tightens jaws on drill and prevents it from falling out. Hardened drive pin is seen here fitted in hex portion

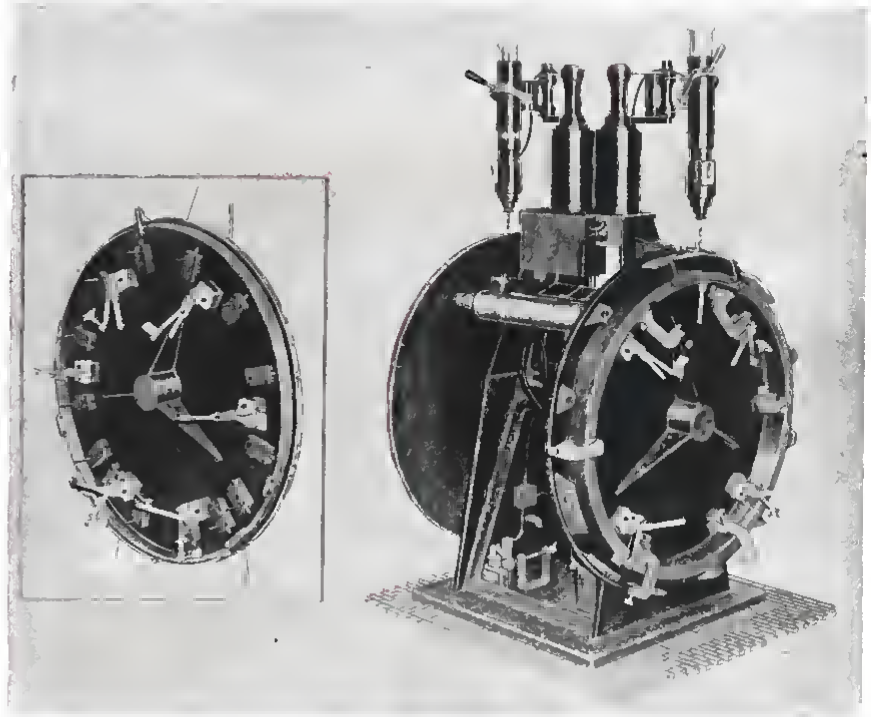


Checking is Expedited By Form Block Hole Gage

• Checking in one operation diameter, corner radius, and angle of form-block holes, this tool saves Curtiss-Wright St. Louis plant both time and material.

Drilling Fixture Speeds Work And Assures Accuracy

• Ford's Willow Run plant designed this compact multi-drilling machine whereby both vertical and radial drilling may be performed at same time. By means of index plate (shown in detail at left) correct spacing of holes is accomplished with speed and accuracy. Large number of hinged clamps enable operator to position work with minimum lost motion



Ingenuity of Serviceman Sparks Air Power Maintenance

Carefully trained in practical techniques and encouraged to think constructively, mechanical specialists of our Armed Forces have developed improved tools and methods, the value of which is reflected by the consistent performance of U. S. air power.

Photos by USN and AAFASC

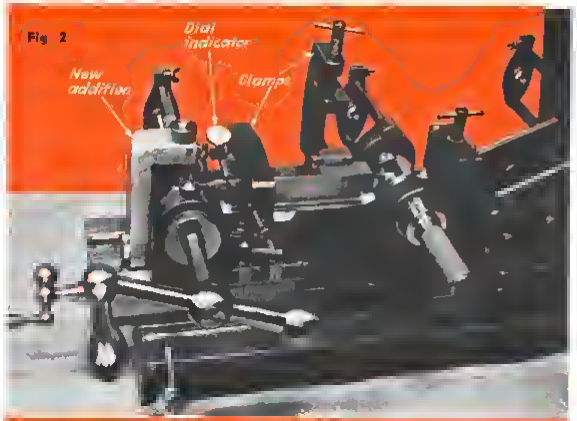
There are two types of mechanics who tend to question the efficiency of the work or tools that the boss hands them. One is the man who merely grumbles, "If the guy who designed this had to use it, there'd be a change." The other, however, is the workman who is ready to use his training for the purpose of improving quality or saving time in performance.

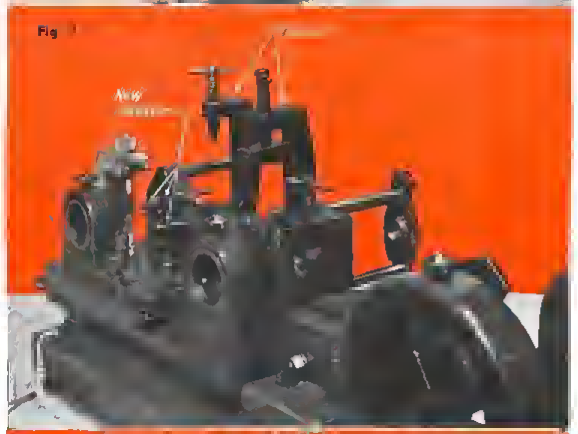
In an Army and Navy staffed by many men who were mechanics before they joined up, and where many civilians with technical training are employed, it is not surprising that considerable ingenuity has been exercised by mechanical staffs. This is particularly evident where distance or lack of transportation has made for difficulties in obtaining working equipment or supplies.

Frequently, too, the accelerated pace of Army or Navy maintenance has led to changes in materials, machines, and procedures which, in fact, had been judged as giving first class satisfaction under prior peacetime operations.

In this picture feature are revealed pertinent examples of the long list of effective Service developments.

Fig. 1 *Working under conditions like these requires a vast amount of ingenuity because trailer workshop, though equipped with excellent, and efficient tools, is not large enough to carry a complete overhaul shop. Nevertheless service mechanics manage to rebuild planes and engines with what they have plus what they make for themselves. (Fruehauf Trailer photo)*





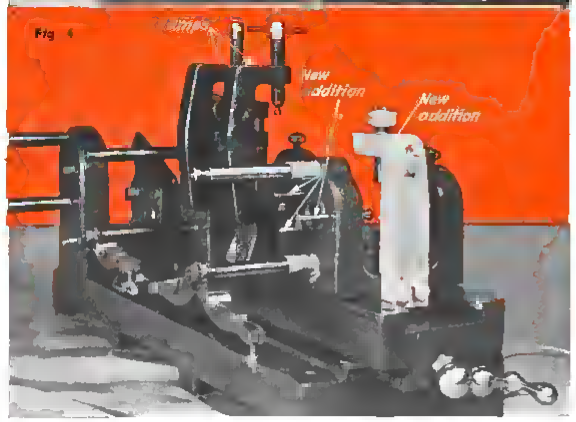


Fig. 2. *Master end articulated rod boring machine with rod in position for boring left-hand end. At right is knurled pin which locates end of rod not being bored thus insuring that both bores will be parallel. Hinged clamps at center hold web of rod firmly. Dial indicator is kept in contact with work to show any deflection which might occur while boring. New addition (left) provides additional vertical adjustment and holding security. To H. D. Hawkins Naval Air Station Seattle, goes credit for improvement.*

Fig. 3. *Boring machine shown in Fig. 2, with upper end lower screws of new addition (left), used to give vertical adjustment to rod being set for boring. Clamps are shown hinged upwards to permit introduction of work which will be prevented from tilting by adjustment of four added screws at back. Large circular bearings along left hand side are for boring bar while one at lower right is for mandrel supporting large end of master rods.*

Fig. 4. *Another view of same boring machine but with boring bar removed and split clamps open to permit placing of boring bar after rod has been set in position. At that time hinged clamps—here shown in vertical position—will be brought down and tightened against web of rod. Note knurled locknut on upper screw of new addition (right).*

Fig. 5 *Wraplock hose connections on engine oil lines were difficult to tighten properly with standard ratchet tool until Lawrence L. Hopkins, at Pensacola Naval Air Station, made flat steel tool shown below. Tool prevents strip from being drawn away from surface of hose while tightening. Completed wraplock is shown at opposite end of hose.*

Fig. 5

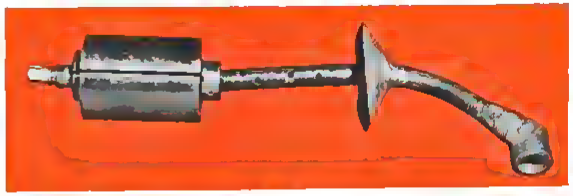


Fig. 6

Fig. 6. *Steam nozzle for blowing grease and dirt out of interior of vacuum pump rotor has resulted in great saving of time over old hand-washing method, and it also leaves parts cleaner. Idea man was Thomas D. Ward Corpus Christi Naval Air Station.*

Fig. 7. *To facilitate hand joggling of long sheets for boat bottoms, Ben Gardner, at Corpus Christi Naval Air Station, welded together at ends two pieces of steel strip, leaving a step where they met. This has made hand forming of work considerably faster and of better quality than by old vise method.*

Fig. 8. *With 29 pushrods per engine to adjust after assembly A. R. Payne and W. Pauli of Sacramento ATSC built this jig, which permits accurate adjustment to each cylinder before assembling engine. Cylinder is locked in place by lever on side of base while pushrods are checked for end play by means of pins seen extending from side. Individual setting can be had with this device in less than one-fourth time formerly required.*

Fig. 9. *Splicing of eyes into control cables has been simplified by welding a spike into pliers not only removing necessity for marlinspike but making wire handling much easier. Maker was Nesem Metalsf, Sacramento ATSC.*

Fig. 10 *Incorporated in Technical Orders because of its merit, this aileron-bearing remover replaces drift and mallet, also obviates necessity for removing aileron from plane when taking out bearings. At (A) is seen fitting for staking new bearings, while (B) is forcing screw with peg which fits into bearing center, and (C) is cup into which bearing is forced when screw is turned down.*

Fig. 11. *Jacobs chucks on high speed drills often damage their outer gear by coming in contact with metal objects while working. To prevent this, J. G. Tarnage of Ester Field, La., attached a short length of tubing to screws of drill, thus forming a sleeve which protects chuck while still permitting it to be tightened.*

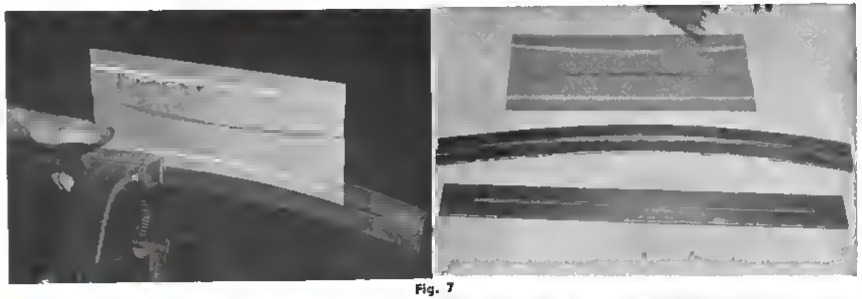


Fig. 7

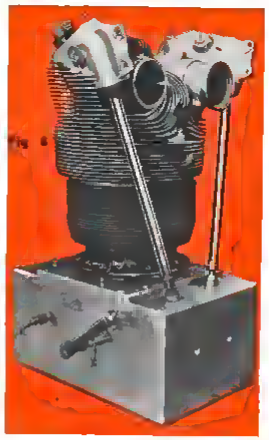


Fig. 8

Fig. 9

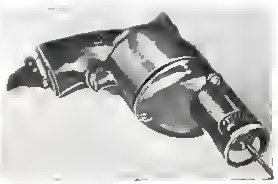


Fig. 11

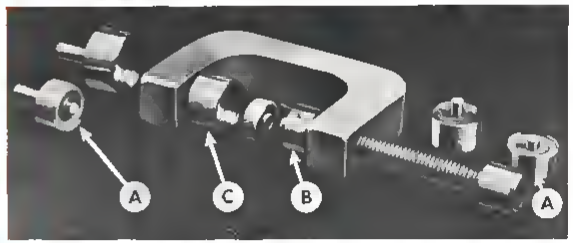


Fig. 10

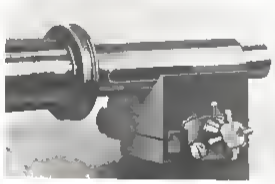


Fig. 12

Fig. 12. *This V block has vernier-adjusted sliding wedges for regulating height of work accurately By doing away with necessity for use of shims as height adjusters Inventor (Lt. E. V. Bobiatt Ephrata, Wash AAB) enabled work to be performed within considerably smaller tolerances*

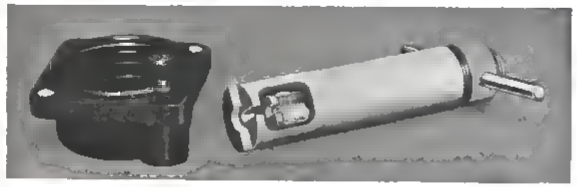


Fig. 13

Fig. 13. *Here tool (right) is for pulling clock knobs without need as formerly for drilling out spindle Threaded and notched center piece fits around and beneath knob and is then screwed out by T-handle, drawing knob with it and leaving clock undamaged. Mechanic Harris Fairfield ASC, devised tool.*

Fig. 14. *Splicing of bungee is made easy by this attachment hinged to a standard cable splicing clamp Inventor was M/Sgt Catling, Repair Sq, 39th AD Group Rubber cord is held at ends as shown then tightened by turning squared roller ends with wrench Splice is wrapped in frame opening*

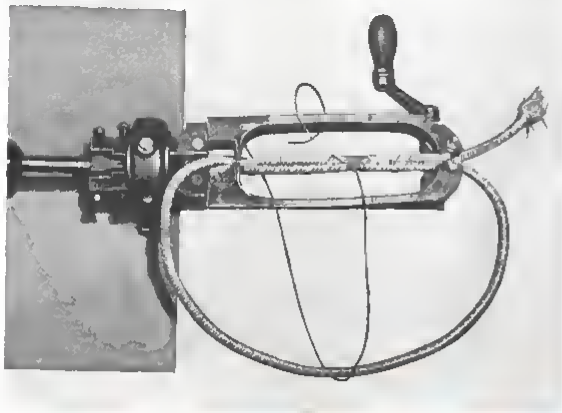
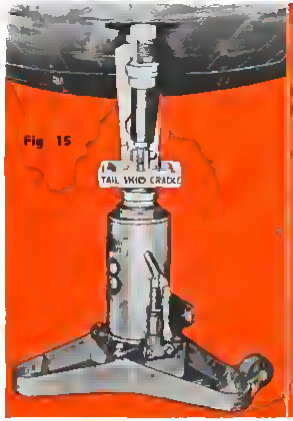


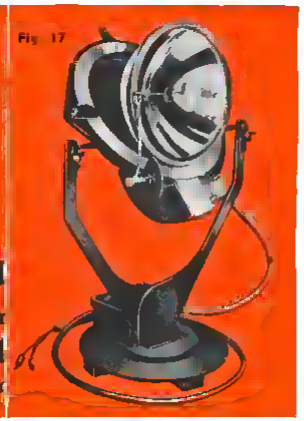
Fig. 14

Fig. 15. *This castered dolly equipped with hand operated hydraulic jack pinch hits for tail wheel when towing crashed planes whose tail wheels have been damaged in landing Cradle at top is provided with hammock made of belting and stretched between pins at sides. Designer was L E Honey Block land Tex AAF*

Fig. 16. *This electrically heated screen repair unit saves 90 percent of solder and half of time formerly required to solder screens W. M. Malone 331st AAFBU Barksdale Field, La. devised this gadget, which has a shallow pan of melted solder into which ends of screen are immersed only far enough to enable to enable a satisfactory soldering job without waste*

Fig. 17. *This stand is for adjusting performance limits on retractable landing lights before installation. Angle of movement is indicated by action of roller on edge of lens. O C Lester Ogden ATSC was inventor*





Successful Overhaul Business Demands Shop Organization

PART V OF A SERIES

By E. F. LINDSLEY

Just as precision has superseded rule-of-thumb in shop work, so too efficient methods of modern organization have scrapped the old "roughed out on paper" way of starting an overhaul business and also the antiquated "notebook and rusty spindle" way of doing it. Heres' how—

A PROPOSED OVERHAUL BUSINESS requires a well thought out organization plan, some of the more obvious advantages of which might be summed up as follows:

First, if it is necessary to borrow money or sell stock, it will be much easier to convince bankers or stock purchasers that this business will return principal and interest or pay dividends, if a clear cut plan of organization and operation is presented.

Second, from the standpoint of a going overhaul business, short term credit will be more readily available if the operator has the reputation of "knowing where his money is". That is, if he can point to his organization plan and say with reasonable accuracy how much money is represented by work in process, how much his spare parts are worth, how many of his accounts are readily collectible, and how soon they may be collected.

Manufacturers, anxious to secure the right kind of dealers and sales representatives, will be impressed favorably by the working organization shown to be good *both* physically and on the balance sheet. In short, the dreams and visions in the back of the operator's head will have little chance to materialize if he doesn't organize the cold realities of his present-day business in a better way than was seen at so many small airports before the war.

An unorganized or disorganized overhaul shop may present such a confusing picture to its owner that he actually may do business at a loss until his capital is exhausted. He may decide that prosperity lies in expanded business, and then fail to realize that not matter how many jobs he takes in, he is not going to succeed by losing money on each of them or by drawing from his aircraft sales to support his engine shop.

It's unfortunate that the systematic overhaul operator who *does* know what various jobs cost him must face this kind of competition when the other fellow cuts prices in a desperate attempt to bring up volume. Eventually, of course, the more business-like operator should win out, unless he grows discouraged and leaves the business to the jackals, as might happen in post-war aviation.

The writer has broken down overhaul-shop organization into two divisions: Organization (1) from a technical and (2) from a business standpoint. These organizations merge into one in practice, but in order to discuss them, it helps to consider them separately.

For the purposes of discussion, let us assume that we are in a position to sit in on the initial organization of an aircraft sales and service firm of rather modest size, to be operated by two men as owners and major executives. Their first job is to decide upon the basic organizational plan, which will probably start with a diagram similar to that in Fig. 1.

At once it become apparent that the

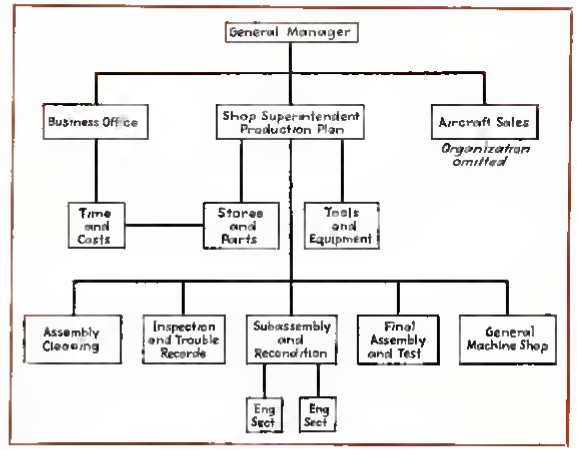


Chart of business organization of an overhaul shop showing relationship of various departments

sales and service functions, while complementary, are for operating purposes distinct activities Obviously, liaison is essential and harm would come from carrying division to the extent that the men responsible for sales and service were ignorant of each other's plans This discussion, however, will be confined to the service organization and we will assume that one of the organizers has taken over the operation of the sales group

Let us start at the general manager's position, where the duties fall under the heading of administration. The company's fundamental objectives must be established and basic policies outlined Many points of the program, once decided, will be hard to alter later on, for instance, the decision whether to operate a general overhaul shop or an exclusive service for customers Policies of finance and specific matters of credit are of utmost importance

Working Plans Essential

Once the primary business policies are agreed upon, certain plans may be mapped out to provide a means of attaining the desired objectives Some plans will deal with the various engines, their sizes, makes, and models that the shop should be equipped to overhaul and supply parts for; other plans will deal with advertising and marketing of the shop's services and spare parts; some attention will necessarily be directed towards financial planning of budgets, payrolls, short term credit and the general problems of business

Now comes the construction of the working organization that will carry out the plans. It is the administration's task to formulate and provide; it is management's job to carry out the function of its department

The shop superintendent, charged with coordinating the shop sections into a smoothly working unit, must be a man of versatile nature. His sense of business, necessary to proper management, must be balanced with an excellent technical background For it is the shop superintendent who sees to the scheduling of the various jobs that pass through the shop, keeps expensive and non-productive back-tracking to a minimum, and sets completion dates with an eye to the over-all capacity of the shop's production facilities. The superintendent must be the final authority on all technical questions, and he must be able to grasp the ramifications of each overhaul job so as to break it down into a logical series of operations.

On the personnel side, the shop superintendent is, in a small organization, the one man with complete authority over worker relations. He hires and discharges, sets up job requirements, grants wage increases, analyzes worker's abilities, and sees that competent personnel are properly rewarded by upgrading that will make them foremen or section heads

The shop superintendent's office provides a central clearing point for purchase requisitions and cost records. Bids for contract work should be subject to the superintendent's approval, for he can tell whether the bid prices are in reason and whether the size of the contract and its narrow margin of profit would actually be worth while or whether it would only tie up production facilities capable of earning more on a series of small jobs

In brief, the shop superintendent holds the reins of the working end of the overhaul business. It would be impossible for the best overhaul shop superintendent in the world to have his fingers on each minor function of the entire shop; to attempt this would result only in chaos On the other hand, secondary supervision need not be very large for the ordinary overhaul shop Usually, one or two high class men are quite capable of handling the stores and parts section

It is unfortunate that storing of parts and materials is too frequently classified under the somewhat disparaging term, "stockroom" In many cases, a large part of the organization's working capital may be tied up in "stockroom" functions — maybe so much capital, in fact, that the very financial success of a company's first few years in business will depend on its turn over Aviation parts are notoriously expensive and are not likely to draw much interest in a stock bin It is not uncommon for an overhaul station operator to pride himself on a sharp purchase of large numbers of seldom-called-for spare parts True, some goodwill accrues to an operator when he is able to fill an order for an obsolete part that no one else stocks. When this goodwill outweighs the money buried in the parts, it may be good business, but nine times out of ten the goodwill can only be classed as abstract, with the worthwhile business derived remaining negligible

One of the business features peculiar to aviation is the necessity for sticking rather closely to the original manufacturer's parts Whereas, a man in the butter and egg business is able to make money on speculative maneuvers that entail buying where he can get the best price and selling when he can get a better price, the airplane engine overhauler would shortly find his overhaul station minus its approved rating if he shopped around for crankshafts, or cylinders It is possible that something along this line might work out in the used airplane field, within limits, but wildcat operation does not belong in the field of responsible engine overhaul

In the overhaul shop, it's essential to have parts and materials of the right kind, in the proper amount, and in the right place when needed It is the duty of the stock control section to fulfill these essentials In less poetic and more practical terms, the job involves procurement, receiving, storing, external and internal disbursing, standardization, salvage, and inventory control This last phase, inventory control, means more than simply ordering a new supply when the bottom of the barrel becomes visible. It means, when applied to spare parts sold to customers, that the goods will be purchased with an eye to anticipated business, seasonal fluctuations, local business conditions in aviation, general business conditions, and the approaching obsolescence of the part itself

Buyer Must Be Alert

From the standpoint of parts and materials used by shop personnel, the stockroom buyer must anticipate new jobs about to enter the shop, consider recent sales of a particular airplane or engine within the market area, and provide for expected cutbacks in contracts, also for substitutions of new designs for old parts. In the latter case, the engine manufacturer usually maintains a stream of information to help the overhaul shop operator keep his spare parts up to date Plainly, it is an unbusinesslike procedure to order a large quantity of a certain part just before a design change or rework makes the item useless.

In the small shop, the order for materials and parts will originate within the stockroom on the strength of a depleted supply or on advice from the shop superintendent that a certsin job will require the item The order, once approved, will then be passed on to the company's general business office where the actual buying will take place When the material is received, it is the responsibility of the stockroom to inspect it and make the necessary inventory records Adequate storage measures are absolutely necessary to prevent damage from corrosion, handling, or mixing with similar parts

Larger organizations, such as airlines or factory shops, usually operate through the main company purchasing department and keep accurate records on all inventories The smaller shops would benefit by following suit. Large airline shops have a certain advantage, for while it is important that they accurately peg overhaul charges, their jobs are all grist for the same mill If one engine ships through without an accurate cost record, it may be annoying; but the same engine, or another like it, will be along sooner or later The overhaul shop operator must peg his job cost, once and for all, if he is to provide the customer with a fair and reasonable bill, also if he is to know how to estimate the next similar job, which may not come in until so long afterward that everyone has forgotten the details that mean the difference between profit and loss

Although material and parts costs may be relatively small in some cases, it is up to the stockroom clerks to charge for materials allocated to any given job If there is leakage and waste at this point, it represents an unnecessary loss that is magnified when future jobs are bid on the basis of previous improper charges.

Standardization of materials may well start in the stockroom Small parts, sealing compounds, cleaning chemicals, and the whole array of miscellaneous items that help keep a shop in operation, sometimes run into confusing amounts because of piecemeal purchasing and lack of standardization A laborer in the parts-cleaning section becomes familiar with certain cleaning compounds He knows what strength to expect from a given brand and, as a result, the cleaning processes are uniformly satisfactory

If, however, the stockroom constantly shifts from one brand to another, the cleaning section operator finds that the work is not uniform. Futhermore, he must go through the routine of draining and refilling his tanks because he doesn't dare mix two different brands of cleaning solvent This is a small example of the almost certain trouble accruing to the hit-and-miss purchaser

Some overhaul station operators, desirous of setting up attractive prices, will allow parts to leave their stockroom for the same price they went in This naturally entails a loss, for the overhead and handling cost involved in purchasing and storing's worth something, as is the rent of the storage space consumed Furthermore, since inventoried parts represent capital, it is not unreasonable to charge at least a slight interest on them

Another secondary supervision and indirect labor section, common to all shops, is the toolroom In using this term, I do not refer to the machine shop charged with producing precision jigs, gages, and special items for production; rather, I mean the task of providing the proper piece of equipment at the proper time

Roughly, the tool section's functions break down into issuing, receiving, storing, and maintaining tools. Here, the internal problems parallel those of the stockroom The toolroom head must provide adequate equipment for any job that enters the shop Special needs should be anticipated beforehand to prevent production tie-ups and makeshift tactics It is part of the job to maintain a practical, working, tool inventory at all times. More than anyone else, a mechanic knows how an active interest in the work changes to inward disgust when there are constant turn-downs from the toolroom due to lack of items that should have been ordered long since. Here, is one important contact between the employee and management Adequate tools, in first class condition, do more than might be expected in the improvement of workmen's morale

Referring to Fig 1, it will be noted that the time and cost section is another secondary supervision between the front office and the shop Time and cost could handle all the details of timekeeping, payroll, social security, unemployment compensation, income-tax withholdings, and possibly industrial insurance and personnel records As a rule, though, the greater part of this work is handled in the business office, while the time and cost section devotes itself to direct contact with the shop Timekeeping is a rather routine matter, unless some special job rates or production bonuses have been established, but complexities from the latter are rare in the ordinary overhaul shop

More important, from the business viewpoint, is the proper allocation of labor charges to the various customers' accounts These records must be transferred to the business office for billing, and it will be a matter of selecting the job record system best suited to the particular needs. It would be worthwhile for any overhaul station operator to read some of the excellent publications on this subject and to visit some of the more enterprising automobile shops for suggestions on labor cost allocation

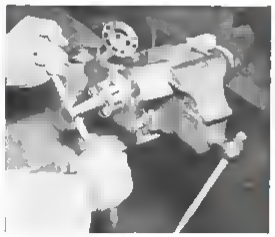
So much for the mechanics of doing business There is still much that should be said regarding the mechanics of staying in business—of knowing exactly how much money is being made or lost, and just where the shop is making or losing it Ignorance of the cost of doing business, as mentioned earlier in this article, is a common cause of business failure Useful cost records allow proper charges against any given customer's account and provide a basis for future bids on new business They show what types of work are profitable or unprofitable and tell the shop superintendent which sections are operating efficiently and which ones need closer attention

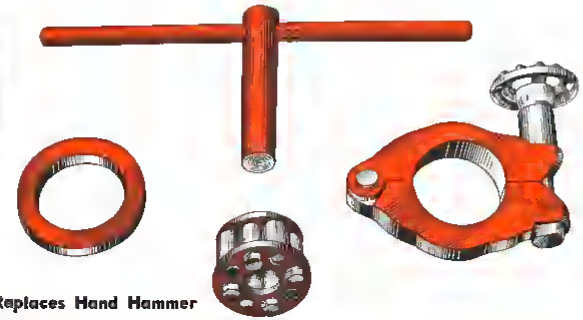
Certain practical truths have long since been proven on the subject of costs For one thing, the person that sets up the cost system should not have an accountant psychology. Here, cost recording should not be complex or detailed to the last fraction of a penny; neither, should it be so exacting that it costs more than it saves The system should show the reasons for keeping costs and how they may be reduced, it

(*Turn to page 271*)

Typical large stockroom where everything from small parts to complete fuel tanks are quickly accessible. (TCA photo)

AVIATION'S MAINTENANCE NOTEBOOK



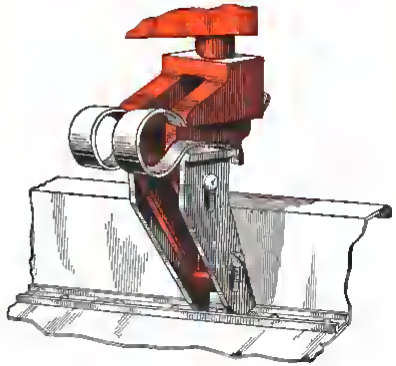


Exhaust Stack Expander Replaces Hand Hammer

• Using a hinged ring outside exhaust stack and an expander similar to that used by boilermakers, PAA saves 227 man-hours per month at its Miami Base. Device was made by P. Vicari and J. Salas of Latin American Div.

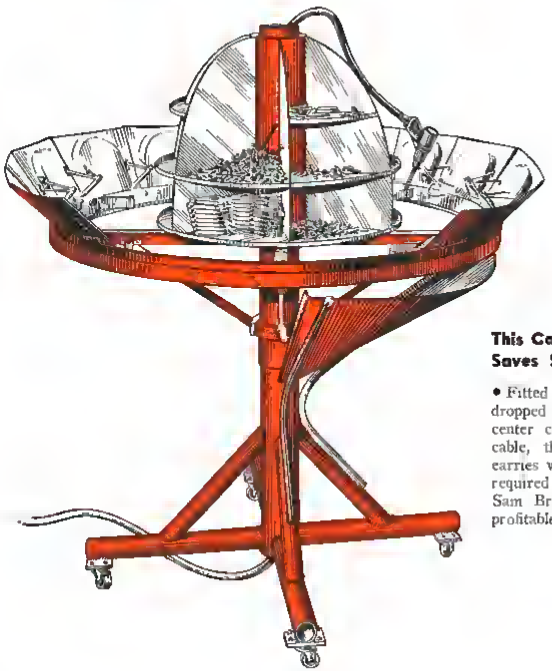
Lightweight Platform Aids Nacelle Workers

• Providing safe, level footing for mechanics working on nacelles of DC-3's, this detachable platform by C & S can be hooked over landing gear. There is no need for special fastening.



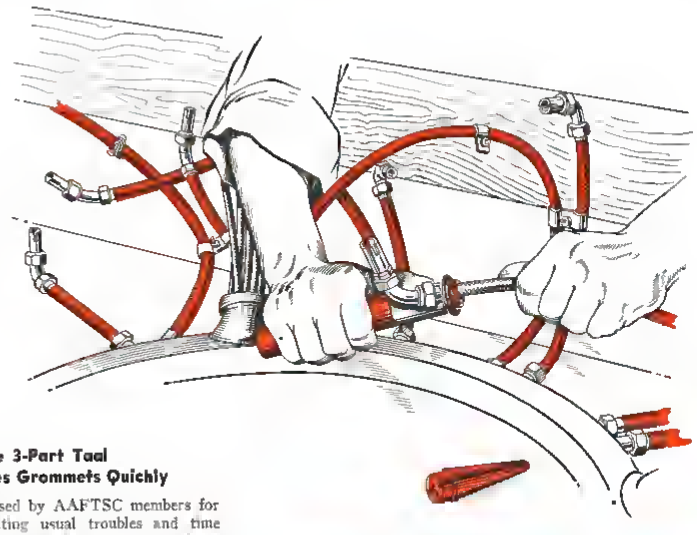
Z-Angles Riveted Easily With This New Attachment

• Using automatic riveter, Convair now rivets Z bars in same time as required for flat work, through application of new attachment developed at San Diego plant.



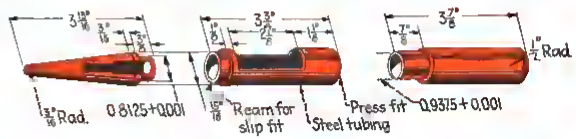
This Cowl Flap Bench Saves Steps and Materials.

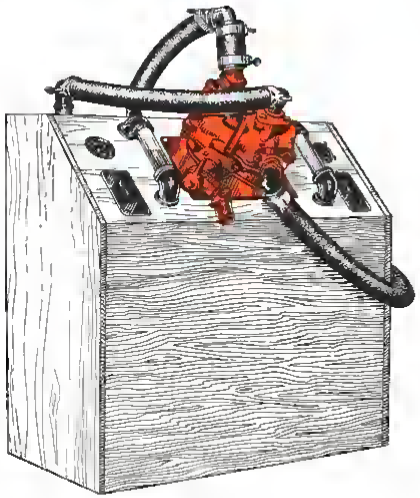
• Fitted with apron which catches dropped parts, and having hollow center carrying air hose or electric cable, this cowl flap repair bench carries with it all screws, parts, etc., required for doing work. Designed by Sam Bracco of AEA, it has been profitable addition to sheet metal shop.



Simple 3-Part Tool Applies Grommets Quickly

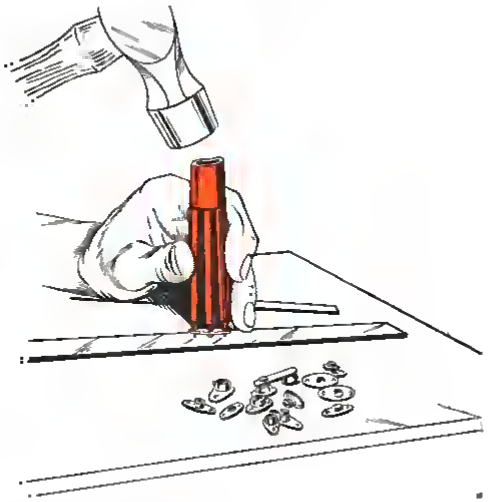
• Devised by AAFTSC members for eliminating usual troubles and time lost when applying grommets to ignition harness, this tool has many similar applications in aircraft shop work. (from ATSC photo)





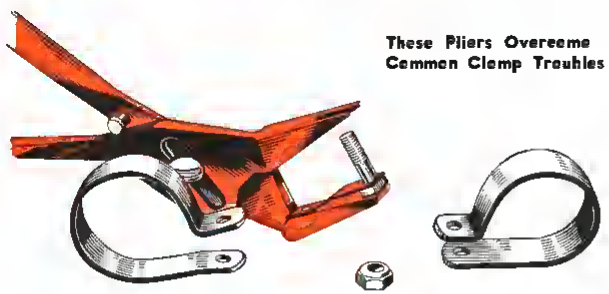
Test Unit Provides Visual Regulator Check

• Maintaining same oil pressure as in engine and regulating temperature by means of Calrod immersion heater, this engine oil temperature regulator test unit was developed by C & S to enable mechanic to check and set accurately regulator units before installation. Lucite tubes enable oil flow to be checked visually during cut-in and cut-out periods.



Multiple Nut Plate Punch Makes Accuracy Certain

• By inserting center guide in nut plate hole, sheet metal operator can mark centers of outer holes by one stroke of a hammer, saving one minute on each nut plate installation and preventing inaccurate spacing. Tool was devised by Emil Slatkovski, of Hawaiian Air Depot.



These Pliers Overcome Common Clamp Troubles

• Old bugbear of installing double hose clamp is overcome by invention of S/Sgt. Otto Maki, of 36 ADG. Special pliers hold head of bolt while it is slipped through clamp lugs and tightened.

Single-Place Skyhopper Offered by New K. C. Company

Aviation Boosters, Inc., to market 50-hp. monoplane specially designed for maintenance ease. Craft, now being tested, is expected to sell for about $1,000. Firm further states other models are in development stage.

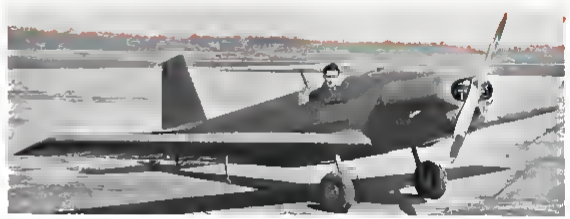
NAMED THE SKYHOPPER, a new single-place light personal plane planned to sell for about $1,000 is now being flight tested by Aviation Boosters, Inc., 3324 Woodland Ave., Kansas City, Mo. The new craft, one of several models this newly organized concern has planned for postwar, was designed and built by George Stark, formerly with Commonwealth Aircraft, and M. E. Salvay, previously connected with North American Aviation.

The Skyhopper has a wing span of 25 ft., an over all length of 18 ft., and a maximum height of 5 ft. 3 in. Gross weight is 850-lb. and weight empty 612-lb. Wing loading is 8.5 lb. per sq. ft. A 50-hp. Continental fuel-injection engine gives the plane a 125 mph. top speed and a cruising speed of 110 mph. Cruising range is put at 275 mi., with a 10-gal. fuel capacity.

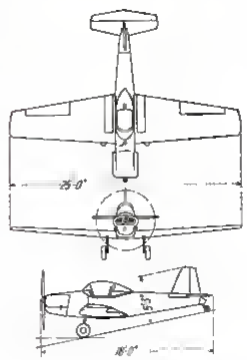
A two-spar wood and plywood fabric covered wing is used. Fuselage is of welded steel tube construction, faired and fabric covered. Fixed tail surfaces are of plywood, with welded steel rudder and elevator being fabric covered. All movable control surfaces are statically balanced and have large bearing margins to insure against loose controls. Controls are basically push-pull, with a small amount of cable.

It is stated that the Skyhopper has been designed for a minimum of fittings and joints subject to shock loads and a reduction of points which require frequent inspection. The engine cowl is made in 4 removable sections, each held on with 15 large cowl fasteners. The engine cowling is mounted to the airframe and is independent of the engine.

Hydraulic brakes are used, along with special brake units and parking brakes developed by Scott Aviation. A special hydraulic shock strut, stated to be free of all rebound, absorbs landing shock through a 4-in. strut deflection. A special internal spring, which goes into action after strut shock absorption has been accomplished, is to provide smoother taxiing. Landing loads are carried by a welded steel truss inside the wing. The tail wheel is both steerable and swiveling. Wheels are Hayes low pressure 6.00x6.



Aviation Boosters' Skyhopper is a single-place low-wing monoplane of metal, plywood, and fabric construction powered by a 50-hp. Continental fuel injection engine. At 850-lb. gross weight, top speed is stated to be 125 mph., cruising speed 110 mph., and range 275 mi. Featured are hydraulic brakes, parking brakes, and steerable full-swiveling tail wheel. De luxe model will have sliding bubble canopy.



A de luxe model of the craft will be equipped with a free-blown, sliding bubble canopy at a slight extra cost. The company states that Skyhopper production will begin when WPB regulations permit.

Aviation Boosters, Inc., is also planning a two-place side-by-side model of 65-75 hp. to sell for about $2,000. This craft is to have a tricycle landing gear, slots, flaps, and a variable pitch propeller.

Specifications and Data

Span	25 ft.
Length	18 ft.
Height	5 ft. 3 in.
Gross weight	850 lb.
Empty weight	612 lb.
Wing loading	8.5 lb./sq. ft.
Top speed	125 mph.
Cruising speed	110 mph.
Climb	750 fpm.
Range	275 mi.
Fuel capacity	10 gal.
Seating	Single place
Power	50 hp. fuel injection Continental
Prospective price	About $1,000

Scale model of 310,000-lb. Blackburn commercial flying boat gives some idea of proposed craft's size. Planned as a two-decker, seating up to 160 passengers in pressurized cabin, plane's top speed is estimated at 307 mph. at sea level, with 2,500 mi. range. Six engines, turning six-blade contra-rotating propellers may be jet turbines. All metal construction would be used.

Blackburn Designs 155-Ton Postwar Airliner

British craft would be an all-metal six-engine flying boat carrying up to 160 passengers plus freight in pressure cabin, and possibly combination propeller-jet turbine power plants will be used.

ANOTHER INDICATION that postwar commercial air transport is receiving increasing attention in Great Britain is an announcement by Blackburn Aircraft, Ltd., of a 310,000-lb six engine flying boat as yet in the project stages. The company states that this craft is but one of several types on which preliminary design work has been started by its engineers.

Of generally orthodox design, this particular craft would have a span of 202 ft., be 148 ft. over-all, and gross 310,000 lb. Top speed at sea level is estimated at 307 mph., and average cruising speed at 269 mph. at 15,000 ft.

Several seating arrangements have been planned. Two decks are provided in the 85 passenger version. On the upper deck, forward, is the crew's cabin for pilot, co-pilot, aviagator, radio operator, and engineer. At the rear of this cabin is the crew's rest room. Except for the galley at the rear, the rest of the top deck is given to freight space.

On the lower deck, the forward hold houses winches and other aeromarine equipment, also the auxiliary electric generating power plant. Then comes the forward passenger salon, divided in half by a screen bulkhead, the forward halt with seats for 29 passengers and the after section seating 24 passengers. A central passageway, flanked by toilet and dressing rooms, joins the forward and rear passenger salons. The latter, seating 32 passengers, has the entrance hall to the rear, and aft of this is the baggage compartment.

Carrying 160 passengers and 30,400 lb. of freight and mail, or 85 passengers and 57,700 lb. of freight and mail, estimated range would be 2,500 mi. These

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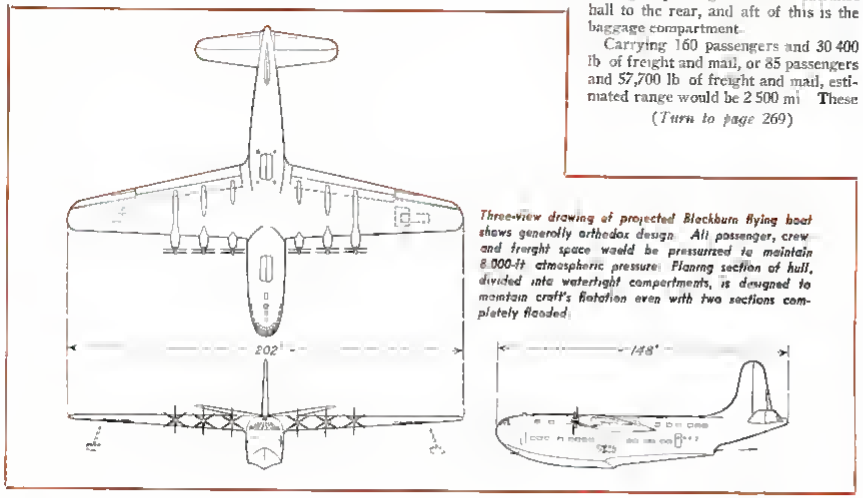


Three-view drawing of projected Blackburn flying boat shows generally orthodox design. All passenger, crew and freight space would be pressurized to maintain 8,000-ft. atmospheric pressure. Planing section of hull, divided into watertight compartments, is designed to maintain craft's flotation even with two sections completely flooded.

WHY'S AND HOW'S OF GOOD AIRPORT TURFING

For laying the dust bogey, grass-surfaced airparts and runways are prescribed as both economical and easily made, if certain basic conditions are fulfilled.

THOUGH AN AIRPLANE can land on any smooth and level surface, there are many reasons why an airport should not consist of merely a flat stretch of bare ground.

First of all, and most important, is the dust problem. Even in black-soil sections of the country where there is abundant rainfall, there are always times when the surface of the airport is dry and ready to be beaten into dust by arriving planes or automobiles.

Of the non-routine causes for wear and tear in aircraft, dust is easily the most formidable and costly. Dusty landing strips permit clouds of gritty dirt to be formed, which are sucked into the engine and permeate the entire structure of the airplane causing rapid deterioration and expensive repairs.

An example of the bad effects of dust on control cables was brought to the writer's attention recently when a comparatively new lightplane was brought in to get a complete new set of rudder and elevator cables and their pulleys.

Dust from an unturfed airport had infiltrated the fuselage and had become trapped between the cables and pulleys. Result was that the cables had chafed until they became stranded, and the grooves in the pulleys were so badly worn that they would not accommodate the new cables and hence also had to be renewed. By the time this plane was again ready for flight the bill was well into three figures.

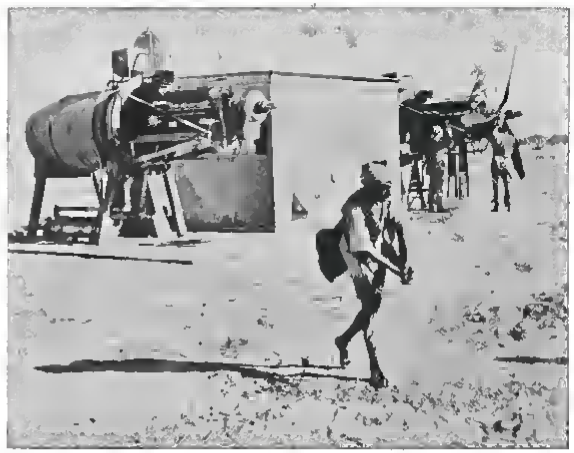
Now, this wear was certainly not due to bad design, nor was it caused by poor materials. There was no method of preventing it as long as the owner kept his plane at that airport. So, he moved to another airport—one covered with good turf—and profitably balanced the increased cost of travel against the longer life and lessened repair bills. Moreover his description of the effects of dust at the former field caused several of his acquaintances to leave that port also.

This is not an extreme instance. A dusty field means dusty work benches and gritty engines. Even with the best intentions and the strictest precautions, whirling dust cannot be kept out of a hangar unless business is so slow that the doors are never opened! The only remedy is to prevent the dust from being formed and the most effectual and economical method is to seed the field to grass.

To the uninitiated, this is thought to be merely a matter of throwing down seed and letting nature do the rest. In reality, though nature does do most of the work, quite a lot of preparation is required before nature will consider the ground as worth the trouble. The fact that grass seems to grow everywhere invading flower beds and encroaching on country roads, does not mean that it is producing the same results as would be required for an airport. If even 20 percent of the grass survives, it still makes quite an impressive showing, but there is a lot of bare ground in between the clumps.

Speaking on the subject of small airports, Charles I. Stanton, of CAA, recently declared: "Good turf is satisfactory for the average small airport. A good turf field with runways in two or more directions, making it usable 90 percent of the time, could be built for the cost of a single paved flight strip which is safe less than half the time."

Unfortunately for the grass, airfields are not selected because of the type of soil, but for flying and accessibility. Seldom is the character of the soil given much consideration, in spite of the fact that establishing a good turf on the airport is a farming problem, pure and simple.



Not a blade of grass in sight at this port in India, so they have to hire natives to sprinkle water on ground to lay dust before starting engines on test stands.

Expansion-growth system. When first planted, tufts of grass are 3 to 10 in. apart. (F. H. Woodruff & Sons photos)

Second stage of tuft growth. Ground between tufts is partly covered by spreading of nodes.

Final stage of growth where nodes have grown together into a tough sod permeating entire soil of the area.

Grass grows almost entirely in the topsoil, even though a few long roots may, in time, penetrate deeply. Since we are safe in assuming that few operators have a thorough knowledge of soil types, we can also be within reason in considering that the soil in question is not too well adapted for grass growing.

To produce a well covered field, first of all the ground must be put in shape for the seed. This is a double operation—cultivation, then fertilization.

Grading should be carried out with the idea constantly in mind that grass will later be sown on the surface. The light, fertile top soil should be scraped to one side before filling in low spots, then this soil should be brought in again when the heavier grading is finished. If possible the grading should be done in plenty of time to allow the ground to settle before seeding. A very slight crown on the runway surface will allow rain water to drain off into the surrounding areas, where it will be evaporated by wind and sun. Any weed growth may be effectively held down by occasional mowing, which will prevent it going to seed.

Fertilization may be handled by spreading about 500 lb. of farm fertilizer per acre and disking into the soil. Seeding should be done either in the fall or in early spring. If this operation is not completed before the end of April, the young grass will probably be badly handicapped by the hot weather during the summer months.

Great care should be exercised in selecting the types of grass to be used, and an opinion should be obtained from the state department of agriculture as to the best mixture for the soil and climate.

There are two approved and well tested systems in use for propagating a good turf. One is the old-time method of seeding and then nursing the crop along until it is sufficiently established to take care of most of the commoner weeds without being choked out in the process. The other is by planting small crowns or nodes at distances varying from 3 to 10 in. and then waiting for the natural sidewise expansion to fill the intervening space.

Each system has its advantages and its advocates, and the airport owner may consider them and decide which way best suits his own program of obtaining a satisfactory turf with the least expenditure of time and money.

Truthfully, there is no royal road to obtaining good turf. The CAA states that an expenditure of about $100 per acre is not an unusual cost. This sounds like a lot of good money to bury in the ground, but a glance at our accompanying chart will show that an acre in area means about 430 ft. of runway 100 ft. wide, sufficient as long as no night landings are contemplated. This works out to about 21c per running foot of runway, which sounds better. If night landing is part of the program, then the runway width will have to be 150 ft. in order that the field may be an approved landing area.

Taking first the seeding method of starting turf: It will be necessary to choose the mixture of seed best suited to the soil and climate. If the airport is completely out of a farming area so that there will be no danger of crops being choked out, crab grass can be seeded. This grass is classed as a weed in farming districts because its growth is so strong and its spreading habit so persistent that few crops can withstand it. However, it forms a very thick and durable sod, provided that there is nothing within a quarter of a mile to be bested by it in the battle for existence. Apart from the characteristics named, crab grass has no objectionable habits. However, before seeding it, consult your local agricultural experimental station for advice.

Of the other grasses adapted for airport use and at present obtainable the following appear to have general approval:

Astoria Bent is an underground creeper. This very desirable feature enables the grass to repair damage which would otherwise cause bare spots. Also known as *Colonial* or *Rhode Island Bent*.

Perennial Ryegrass makes a beautiful lawn in combination with the two following grasses.

Canada Bluegrass, which will grow on dry, sandy, gravelly, or clay soils and stand either extreme wetness or drought.

Creeping Fescue or *Chewings Fescue*, giving a fine silky turf and which will grow even on sandy soils.

Seaside Bent, hardy enough for putting greens on golf courses. Like all bents it is an underground creeper and tends to over-run flower beds or open spaces.

Red Top, a perennial grass used to give a quick start since it accommodates itself to a variety of soils and climates. Will flourish on soils deficient in lime.

White Dutch Clover, the only seed not in the grass family which is used for building a sod. It is adapted to both wet and dry climates.

Bermuda Grass, the basis of most southern turf. A tropical perennial which grows either from seed or by spreading habit.

Annual Ryegrass, which as its name indicates lives but one year. For this reason, is used chiefly to give a quick covering crop during the time when slower perennial grasses are maturing.

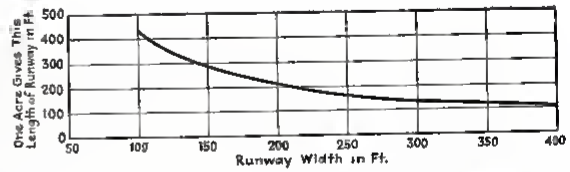


Chart shows length of one acre of runway in feet for various widths

Obviously, though each variety of grass has some special quality, a mixture comprising several types having special properties is frequently indicated. O. M. Scott & Sons Co. advises use of the following mixture for airports where climatic or soil conditions are not exceptional:

40% Kentucky Bluegrass
15% Red Top
10% Perennial Ryegrass
10% Hulled Corean Lespedesa
10% Orchard Grass
10% Chewings or Creeping Red Fescue
5% Wild White Clover

Such a mixture would cost in the neighborhood of $35 freight paid per 100 lb., which would cover an acre with good growth in the first season. Good results may also be obtained by seeding at the rate of 75 lb. per acre and waiting for subsequent growth in the second year.

Use of 500 lb. of farm fertilizer previous to seeding is advisable, and this added expense is justified because the resulting growth is very much better.

While fall is a better seeding time than spring, it is usually safe to seed at the beginning of the year before the end of April. If seeding is postponed later than this date, summer heat will damage the young growth.

Large airports can advantageously use such units as this "Grass Blitzer," which runs at 20 mph. and cuts 400 acres a day. (Worthington Mower Co. photo).

Runway grass should not be cut as short as a lawn. For small airports where the total runway area may be less than 20 acres, the mowing contract can advantageously be let to a neighboring farmer. Grass should not be cut oftener than is necessary to keep down high growth and weeds, because as much as 20 percent of the plant food in the soil may be withdrawn by the expedited growth entailed in frequent cuttings, necessitating additional fertilizer at intervals of two or three years.

The second method of turf propagation—by means of planting small tufts or nodes—is a system which has been proven many times to give an extremely tough sod, a leading example being the U. S. Army's Honolulu parade grounds, which get plenty of wear. Advantages are that after the turf has completely covered the ground it is practically indestructible under normal airport wear.

To obtain coverage in the same year, it is necessary to plant with 3-in. spacing, which entails considerable work. If it is not necessary to have complete coverage until the end of the second year the tufts may be placed twice this distance apart. And on a "long range" program, spacing may be as much as 1 ft.

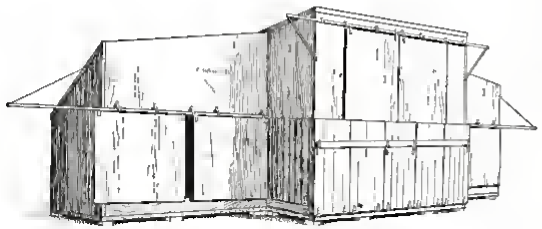
In any case, this system does not give as fast growth as the seeding method. Much of the growth goes into spreading roots, and accordingly not so much cutting is required. In fact, one variety of "Flawn" stops growing at between 4 and 5 in.

Large airports have a special grass cutting problem. Where there are 500 or 600 acres to be cut, the manager has the choice of two courses. Either he can use ordinary cutting equipment and keep it constantly in use, selecting machines of a size which will just keep abreast of the growth, or he may invest in a modern high-speed mower which will care for the largest airport in two days and then may be removed from the field until the grass grows up again.

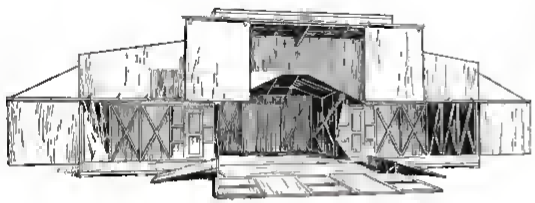
Prefabs Show Real Promise For Postwar Hangarage

By EDWARD E. THORP, *Assistant Editor, "Aviation"*

Peace is seen bringing a big—and consistently growing—need for aircraft housing; and as a means of meeting the broad demand, the readily erected, right priced, small hangar is an odds-on bet. Accordingly, the prefabricators are now ventering into the field, and detailed here are vorying types of structures they think will fill the bill.



Douglas fir plywood hangar built by Halliday Co., Burlington, Ont. to RCAF designs. Having integral plywood floor, hangar may be mounted on wood blocks on soft ground.



Halliday hangar open. Front drops to form ramp, while sides fold or slide to give full opening. Entire front section is supported by cantilever type framework extending from rear. Hangar can be erected by inexperienced labor

UNTIL NOW, the aircraft owner has had, virtually, but two choices in the matter of storing his plane. Either he could rent space in a large public hangar at from $15 to $25 per month, or he could tie down his plane outside with no protection from the weather.

Of course, it has been argued that an airplane which can be flown in any weather should be capable of withstanding that same weather when not in flight. But, like the car parked all summer at the curb, it suffers a slow but inevitable deterioration until, finally the CAA inspector grounds it for re-covering or an equally drastic overhaul.

The individual T-hangar was designed to prevent just this kind of trouble, by providing a weatherproof and secure shelter at a price but little higher than the extra repairs caused by undue exposure. In addition to the longer life expectancy afforded the plane by use of such a hangar, the owner receives an additional dividend in reduced insurance rates and also immunity from damage.

In all parts of the country, manufacturers who have been supplying portable and knocked-down buildings are now building prefabricated hangars which sell for between half and two-thirds of what local costs have been for buildings erected by ordinary methods.

Prefabricated buildings are no new idea. Even before the present war this business had reached large proportions and its growth has been accelerated recently by contracts for barracks, storehouses, and many other types of buildings.

Materials vary from galvanized sheet steel to plywood and lumber, but Douglas fir plywood has become one of the most frequently used materials because of its strength and rigidity when glued to the supporting framework. This plywood also is partly fire-resistant, requiring a much greater exposure to fire before it burns than is the case with plain lumber. The resinous plastic bonding agent, now used instead of old-style glues, will withstand any stresses which do not destroy the wood, and this agent is unaffected by water.

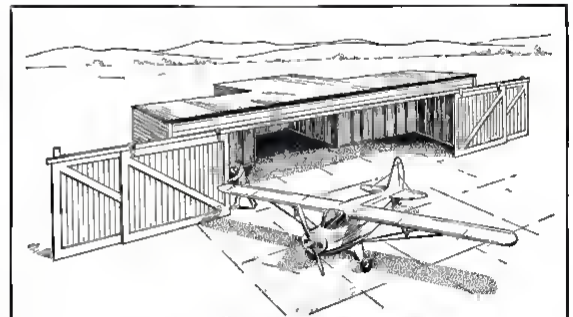
Foundations

If the hangar is to be regarded as a permanent structure, a foundation of some kind will be necessary to keep the sides off the ground. In parts of the country where there is neither drifting dust nor heavy snow, wood blocks will often suffice. These blocks should be given a coat of tar or asphaltum applied hot, to prevent destruction by insects. In many sections of the Southern States this system is used for small building foundations with apparent satisfaction. There is no doubt that blocks are the cheapest form of support for the purpose.

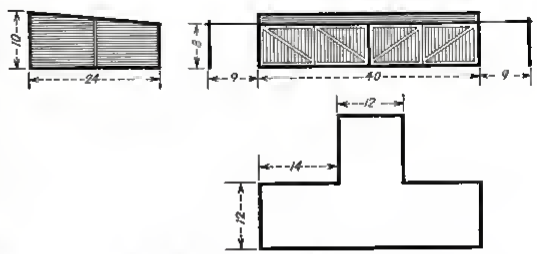
Where concrete foundations are used the increased cost is offset by the resistance to dust, insects, and small animals. The writer has seen a very thriving colony of mice removed from the rear part of a plane which had been stored all winter in a hangar which had no foundation. After paying for removal of his guests and repairing the damage which their housekeeping had caused, the owner of the plane jacked up the hangar and built a concrete foundation beneath it. All the next winter the plane rested alone.

A foundation can be built at small cost, if the owner is willing to do a little manual labor in digging a trench about 1 ft. deep and the same width. The bottom should be leveled off so that the wall will contain the same depth of concrete at all points, otherwise there will be danger of cracking during cold weather. Concrete blocks are satisfactory and frequently can be purchased locally for less than the cost of hauling sand, gravel, and concrete to the site from various supply points.

If it is decided to use a poured foundation, forms should be made of rough lumber, with 2 in. sq. stakes driven into the bottom of the trench

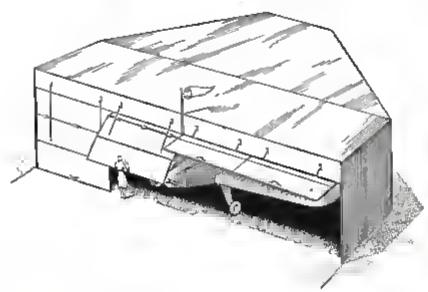


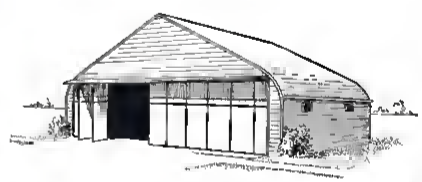
T-hangar by Otto Aviation of Bloomfield, N. J. It sells for less than $600, while labor cost is put at $40. Galvanized steel roof will carry 55 lb. per sq.ft. snow load. Walls are of Transite. Doors are mounted on telescoping track.



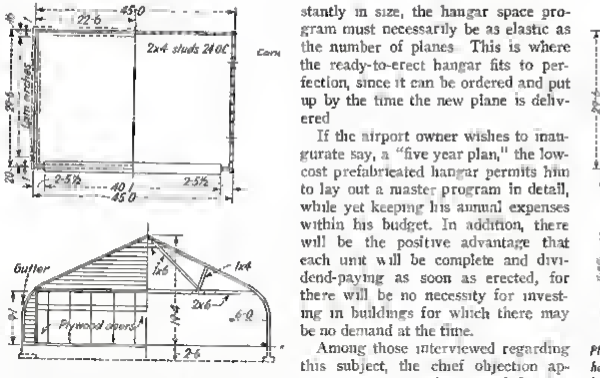
Three-view drawing of Otto T-hangar with 40 ft. door opening.

Pre-fabricated "V-40" hangar by Texas Pre-Fabricated Housing Co., of Dallas measures 40 x 24 x 9 ft. It has sectional canopy-type door folding vertically, saving ground space. Cost is about $600.





Plywood, steel, and concrete hangar designed by Harmon & Peddle, architects for Beech Aircraft Co. Idea is that a hangar should not cost more than half price of the plane. (Courtesy "Practical Builder")



Elevation and floor arrangement of Beechcraft plywood hangar showing simple construction. It's figured hangar could be built by a local contractor for less than $1,000.

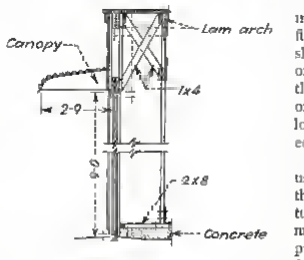
and prevented from spreading by cleats nailed across the top. These stakes are placed outside the boards forming the mould or form into which the concrete is poured. A layer of tar paper on the inside of the boards will prevent any tendency of the concrete to stick to the forms.

As will be noticed from the illustrations, even such a simple thing as a small hangar lends itself to a variety of detail. Since the structure is designed and practically built around the plane for which it is intended, the ingenuity of the builder is limited only by dimensions and materials but is totally unfettered by tradition or architectural prototypes. Consequently, we find ourselves with a number of differing designs, all strictly functional and seemingly equally efficient.

Two classes of users appear to comprise the most promising field for this kind of hangar. In one category is the small airport operator who has but a single standard hangar already filled with planes and tools. In the other is the light plane flyer. Because the personal-plane group will vary constantly in size, the hangar space program must necessarily be as elastic as the number of planes. This is where the ready-to-erect hangar fits to perfection, since it can be ordered and put up by the time the new plane is delivered.

If the airport owner wishes to inaugurate say, a "five year plan," the low-cost prefabricated hangar permits him to lay out a master program in detail, while yet keeping his annual expenses within his budget. In addition, there will be the positive advantage that each unit will be complete and dividend-paying as soon as erected, for there will be no necessity for investing in buildings for which there may be no demand at the time.

Among those interviewed regarding this subject, the chief objection appears to concern the cost of flooring

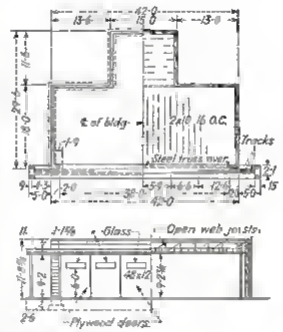


Section Door

Section of door of Beechcraft hangar illustrating laminated arch construction and concrete sill.

the hangar when built. Indeed, with the concrete floor having an average contract price of about $0.24 for work alone and extra for materials and grading, the cost of it may well be one-fourth of the whole expenditure.

Several substitutes have been used with satisfaction. Various asphaltum paving compounds have proved satisfactory. For instance, Stabinol has been used largely by the Armed Forces, with such success that it is likely that this material will be used considerably



Plan and front elevation of Beechcraft T-hangar, showing section of open web joist for stiffening roof.

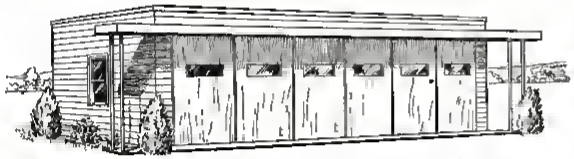
in the future, both as a waterproof floor covering and also to afford a slightly sloping watershed for a space of several yards around the outside of the hangar. Having a life expectancy of five years per application and being low in first price, it appears well adapted for this use.

Certain factors govern the length of useful life for small hangars. Though the new resin glues are rot- and moisture-proof, the wood composing the material requires a certain amount of protection. If ordinary paint is used for the outside finish, it is probable that repainting will be necessary every second year, whereas the new plastic-base paints—sprayed instead of brushed—should give three or four years service even under the worst weather conditions, and longer if the wear and tear are not so great.

In any case, it should be remembered that a smartly painted set of buildings will not only last far longer without repairs, but the clean and neat appearance will likewise prove important in attracting new business.

A weatherproof hangar fitted with a good lock will have its usefulness considerably enhanced by the addition of a good workbench and tool locker. Proposed CAA regulations appear to have in mind the granting of permission to flyers to do their own periodical inspection and light repairs. This will save much small expense and time, which combined in the past to cause a large percentage of the drop in enthusiasm on the part of the owner.

By enabling the small airplane owner to fly more cheaply, these proposed regulations will bring about a greater sale and use of aircraft and will eventually result in larger business to the small airport owner, both through increased sales of oil and fuel and in



Another T-hangar, also designed for Beechcraft by Harmon & Paddie. Folding plywood doors on top track furnish another example of light and economical construction. Cost less than $1,000. (Courtesy "Practical Builder").

overhaul and heavier types of work for which the private pilot is neither sufficiently skilled nor equipped.

Bearing these facts in mind it is quite evident that the prefabricated hangar should find a considerable market in the not-so-far-distant future, providing the prospects come to recognize the fact that they will be dollars ahead by protecting their planes from the elements and through having places where they can turn their spare time into cash savings by doing much of their lighter work.

When purchasing a prefabricated hangar there are several factors to consider. The question of quality—strangely enough—hardly enters the picture,

Grouping Diagram

Method of grouping T hangars with sufficient space between to permit access from all sides in case of fire.

because the firms manufacturing these units are not newcomers in the business but have been fabricating small buildings for many years and have learned the best materials to use and how to work them.

First cost may be divided up into two parts. Factory price and freight. For the reason that longer hauls always cost more than short ones, it is advisable to select a firm near enough so that cost of delivery won't discount the deal. Every manufacturer can quote a very close estimate on freight rates to any part of the territory he usually serves, and so the prospective buyer will not find it difficult to work out a price for the hangar laid down at his nearest station.

It is advisable to request from the manufacturer an estimate of the number of hours of labor necessary to erect the hangar. This should include separate estimates for unskilled and carpenter labor, there being a considerable difference between these two classifications. There is also a large variation in the amount of supervision required, a carpenter being quite capable of working for long periods without

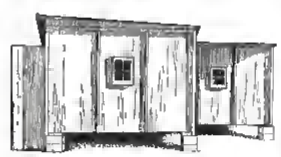
Mellor-Howard seaplane base at Ridgefield Park, N. J., built by John Cooper Co., Hackensack, N. J., for about $4,000. This hangar will handle anything smaller than an airliner. Shop and office are at side.

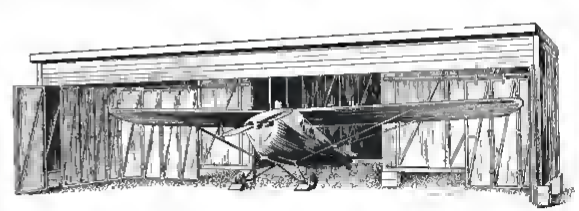
Small airport buildings can be economically built from Q-panel made by Robertson Co., Pittsburgh.

there being any need to oversee his work, whereas unskilled labor frequently must be guided to prevent costly mistakes.

For areas where there are unusual conditions—such as danger of fires from forest or prairie conflagrations, high humidity due to swamp lands, or material—erosion from drifting dust and sand—special materials have been developed. One of these, called RGM, has been used for hangar and other building construction in all parts of the world. Being sheet steel covered with tightly adhering, asphalt-impregnated asbestos, it is both fire and weather-proof. The manufacturer, H. H. Robertson Co., states that this material has weathered many hurricanes and tropical storms without harm or deterioration.

Summing up, the prefabricated individual hangar gives: (1) Safety from fire, unless a general conflagration, (2) safety from theft of parts or tools; (3) protection from accidental damage from operation of other craft; (4) working space for performing many small money-saving jobs; (5) more flying time, since plane is always available when needed without moving other aircraft; and (6) freedom from dust, which is unavoidable in a large hangar where handling of many planes necessitates doors being open most of the time.





Front and end views of Douglas fir plywood T hangar built at Alma, Mich., by Earl Brenneman. Cost approximated $600.

These Traffic Estimates Will Serve Operators and Producers

By WILLIAM FRIEDMAN, *York Research Corp*

Presenting a key method of predicting travel requirements in both commercial and personal planes—in order to guide management in both airline and manufacturing fields.

IN PLANNING for future aeronautical operations, it is necessary to get the most accurate information possible on the anticipated traffic, not alone as a measuring stick for airline operators, but also for those who are concerned with airport planning and management, also those who are to build the necessary aircraft.

In making these estimates, one of the most important factors involved—the amount of increase in mileage traveled by all means of transportation—is often completely neglected or else studied so superficially that the results are of little value.

It is, however, felt possible to evaluate this factor by a rational method that gives results which are much more accurate and meaningful than those derived by arbitrary guessing.

These accurate estimates are necessary for economical production of planes where the methods of fabrication and finance may vary greatly with the quantity to be manufactured. They are needed even more in airport designing. Expert planning can produce an airport which may later be expanded to many times its initial capacity but, unless this planned expansion is based on realistic predictions, the airport may never operate on a sound basis.

Predictions of future air travel are often made by assuming that air transportation will take over varying percentages of the passengers now carried by other means of travel. These percentages are worked out on the basis of time saved, differences in comfort, cost, and other factors. However, although these figures account for diversion of mileage to the air, they do not consider the creation of additional mileage, except that due to expected population increases. In other words, there is an implied assumption that the average person will travel the same number of miles as last year or the year before.

This is an assumption that can be disproved easily by checking past records. In 1925 the number of passenger miles traveled by auto, bus, rail, street car, etc., totaled 291 000 million. By 1940 the population had increased 15 percent and, under this assumption, the new mileage figure should have been 335,000 million. Actually the figure for automobile travel alone was 498—fully 50 percent higher. And that was for autos only—the railroads and buses were still carrying plenty of passengers.

The fallacy is, obviously, that the average person doesn't travel the same distance every year. If he is trying to decide whether or not to make a trip, considerations of distance independent of time enter as factors only in that they affect cost. When our average man doesn't visit a friend 100 mi. away, it's not because he thinks that is a long distance, it's because he feels that 3 hr. or more is a long time. If he could make the trip in 1 hr., he would do it a lot more often.

The one term that appears to remain fairly constant over the years is the time, not the mileage traveled. This can be verified by again comparing the 1925 and 1940 travel figures. Table I lists the number of passenger miles for each type of transportation. The number of passenger hours is determined by dividing each mileage figure by its corresponding velocity. It should be noted that this velocity is not an average cruising speed but the much lower average point-to-point speed, since this is the only thing that interests the traveler.

The total number of passenger hours for 1925 divided by the population in that year shows that the average person traveled about 173 hr. A similar calculation for 1940 gives 176 hr. These two values differ so slightly it will be assumed that the time spent per person in traveling is constant from year to year and is approximately 175 hr.

The most noticeable effect of this is that every increase in the speed of travel proportionately increases the total mileage traveled, as shown in Table II. Thus the airplane, with its high speeds, creates billions of passenger miles of travel. The automobile, if facilities slightly increased its speed, would create sufficient new mileage to more than offset its losses to the airplane for several years to come.

In Table III the 1940 figures are projected forward to 1950. This is done in two steps: First the number

(*Turn to page 261*)

Table I—Comparison of 1925 and 1940 Travel

	1925			1940		
	Passenger billion mi.	Average speed	Passenger billion hr	Passenger billion mi	Average speed	Passenger billion hr
Commutation	6 6	18	37	4 0	23	17
Day coach	15 4	22	70	11 6	29	40
Pullman	14 0	26	54	8 2	34	24
Elec. R. R.	48 0	15	3 20	25 3	19	1 49
Buses	7 0	12	55	21 0	20	1 05
Automobiles	300 0	14	14 29	498 0	25	19 92
Airlines	.....	..	.....	1 1	120	01
Personal Planes	.....	..	.....	6	90	01
Totals	291 0		18 685	571 3		23 29[2]

[1] Gives 173 hr. spent traveling per person in 1925—i.e., 18,680 + 114 (million population in 1925)
[2] Gives 176 hr. spent traveling per person in 1940—i.e., 23 290 + 132 (million population in 1940)

Table II—Variation of Average Travel Speed

	1925	1940	1950
Hours traveled per person	173	176	176
Miles traveled per person	2,553	4 330	6 442
Average speed	14 8	24 8	30 8

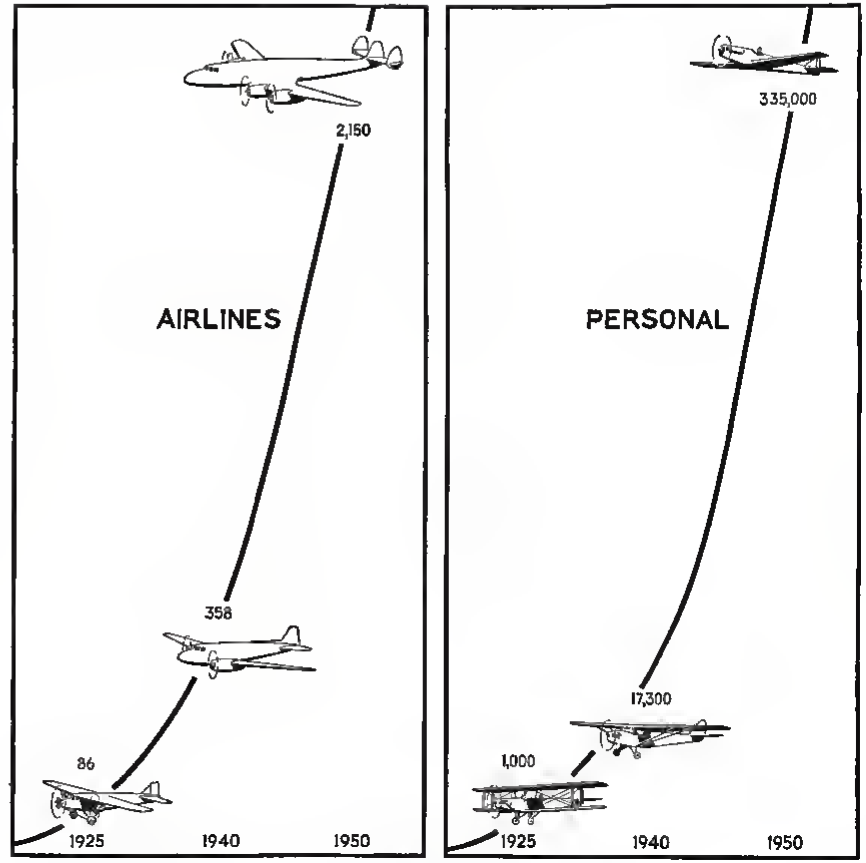


Table III—Comparison of 1940 and 1950 Travel

	1940			1940		
	Passenger billion hr	Passenger billion hr + 5%	Method of redistribution	Passenger billion hr	Average speed	Passenger billion mi
Commutation	17	178		178	27	4 8
Day Coach	40	420	20% to airlines	336	33	11 1
Pullman	24	252	44% to airlines 1% to private	138	40	5 5
Elec. R. R.	1 49	1 564	.....	1 564	20	31 3
Buses	1 05	1 102	.....	1 102	26	27 0
Automobiles	19 92	20 916	1% to airlines 5% to private	20 707	30	621 2
Airlines	01	010	Increase as above	226	140	31 6
Personal planes	01	010		201	105	21 1
Totals	23 29	24 452		24 452		754 2

[1] Gives 178 hr. of traveling per person in 1950, i.e., 24,452 + 138.6 (million population in 1950, gaged as 1940 + 5 percent)

Table IV—Planes Needed to Carry Air Traffic in 1950

	Airlines	Personal planes
Passengers per plane	39	2
Hr. per plane (per yr.)	3,500	300
Passenger hr. per plane (product of above two items)	105,000	600
Billion passenger hr. per yr. (from Table II)	226	201
Planes required (quotient of above two items)	2,150	335,000

Distant Reading Compass Takes Lag Out of Headings

By M. J. WAINWRIGHT, *Pilot Officer, RAF*

New instrument gives steady, accurate heading even while plane maneuvers or takes evasive action. It also works in conjunction with automatic pilot, air position indicator, and bombsight.

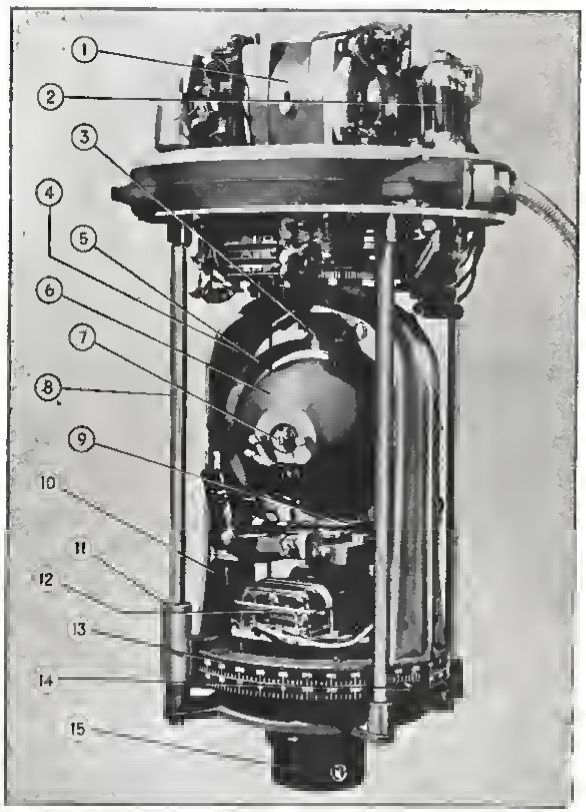


Photo of direct reading compass cover removed shows (1) Rotary converter, (2) short circuit resistance (3) pivot (4) outer ring of gyroscope (5) inner ring, (6) fixed half of gyroscope, (7) axis on which free half of gyroscope rotates, (8) outer frame, (9) contact assembly, (10) inner frame (11) cylindrical weight for vertical balance, (12) north-seeking magnet, (13) scale, (14) index pointer, and (15) corrector box for local deviation.

INCREASED ACCURACY IN AVIGATION has been made possible with the development of a new instrument known as the Distant Reading Gyro-Magnetic Compass, which is capable of indicating a steady heading in different parts of an airplane simultaneously, unaffected by acceleration, deceleration, or moderate evasive action.

In the early days of the war, the old magnetic compasses were still in use. Unstable and sluggish during maneuvers, they were particularly inaccurate if situated near armor plating, and they had up to a 30-deg error after an airplane's guns had been fired.

Then the Royal Aircraft Establishment, at Farnborough, began research on a distant reading compass, and the instrument developed is now in general use with the AAF and the British Empire air forces.

As indicated, the main function of the new compass is to show magnetic north in several parts of an airplane at the same time, undisturbed by local magnetic fields set up by electrical circuits, ferrous materials, or by the movements of the craft; and it is also designed to work in conjunction with the automatic pilot, automatic bombsight, and air position indicator.

The installation comprises a master unit, normally located in the tail and remote from armor plating and electrical circuits, repeater compasses for the pilot, avigator, and bombardier; and a variation setting corrector making allowance for local variation up to 30-deg east or west of due north.

This master unit is the installation's main component. It consists of a gyroscope, a north-seeking magnet similar to that in an ordinary compass, and an electrical transmission system through which the airplane's headings are shown on the various repeater compasses. The placement of the unit cuts down local deviation to a point where it can almost be ignored. The magnetic element, therefore, takes up a position which accurately gives the bearing of magnetic north. Mounted above this is a high speed gyroscope spinning at approximately 12,000 rpm. in a gimbal system which maintains rigidity in space whatever the plane's movement. These two elements combined give an accurate bearing of magnetic north in all attitudes of flight.

A small gyroscope always has a rate of precession which over a long period of time would give a considerable error. In normal straight and level flight, therefore, the magnetic element is the controlling factor in determining the heading of the craft, and the precession of the gyro is corrected, by means of a switch which closes a circuit to electric magnets, whenever the two elements are out of alignment, thereby applying a torque to the gyro and precessing it in the required direction until the two units are aligned.

When the aircraft makes a turn, the gyro remains stable and continues to give the plane's correct heading, apart from a slight error of not more than 1 deg. because of the deflection of the magnetic element by the vertical component of the earth's magnetic field.

On top of the gyro unit is a wiper arm which completes the circuit for a motor driving the inner case of the master unit in the opposite direction to that in which the plane is turning. These movements of the inner case are transmitted to the repeater compasses (situated in other parts of the craft) by means of a screened three-wire system to a series of separate three-phase synchronous induction motors located in each repeater compass.

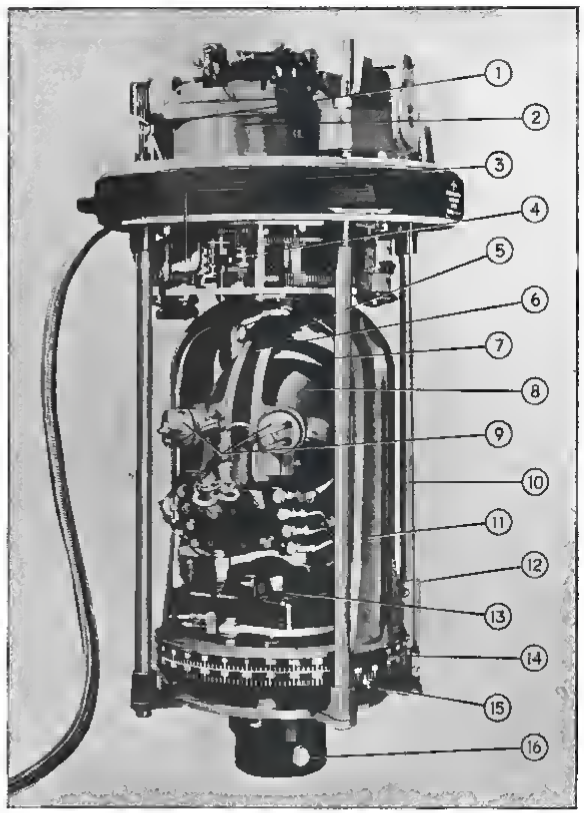
An ordinary magnetic compass involves considerable work for an avigator since the magnetic poles are not coincident with the geographic poles. The angular variation changes not only from place to place on the earth's surface but is constantly undergoing change in the same place. An allowance for this is made in the distant reading compass by means of the variation-setting corrector. In ordinary compasses magnetic readings are converted to true directions by applying local deviation and variation.

In the new instrument, deviation is almost negligible and variation is set automatically and instantaneously by means of the variation corrector, which increases or decreases the readings of the repeater compasses relative to those of the master unit, according to the easterly or westerly variation set on the variation corrector dial by the avigator.

To prevent accidental de-synchronization of the repeaters with the variation corrector when the compass is switched off by movement of the corrector knob, a magnetic clutch is included. This dispenses with the necessity of checking the synchronization of corrector with repeaters every time the airplane is flown.

Thus it can be seen that the distant reading compass gives accurate, true headings in several parts of the craft at the same time in banked turns, during evasive action, in climbs and dives, and while accelerating and decelerating, meanwhile placing little responsibility on pilot or avigator. It is controlled by two switches: An "on-off" switch, which is set in the "on" position before the plane is moved and in the "off" position only after landings when the craft is finally at rest; and a "normal setting" switch, which is generally used only before flights. When the compass is first switched on, the gyro may not be correctly aligned with the magnetic element. Normal rate of precession of the gyro is about 5-6 deg per min and reduces the time to about 3 min.

(*Turn to page 247*)



On opposite side of compass is seen: (1) Two-way relay, (2) reversing electric motor, (3) electrical transmitter, (4) transmitter, (5) pivot, (6) outer ring of gyroscope, (7) inner ring of gyroscope, (9) gyroscopic rotor, (9) electro-pot magnet, (10) outer frame, (11) inner frame, (12) cylindrical weight for vertical balance, (13) north-seeking magnet, (14) scale, (15) index pointer, and (16) corrector box for local deviation.

Superfort Mockup Is Ditching Classroom

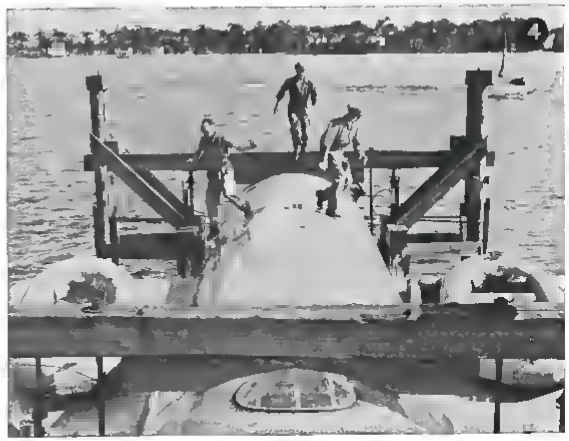
Getting eleven men out of a 65-ton Boeing B-29 after it's been ditched in the blue Pacific takes a precision technique developed by painstaking practice. Seen here is how the crews get—realistically—that vital practice in a special bomber mockup rigged at Lake Susannah, Fla.

1. Top: In the forward pressurized compartment, B-29 pilot prepares for impact by bracing feet on rudder pedals, knees flexed. Superfort commander (not shown) takes same position. Bombardier lies sidewise on floor, his back against commander's aisle stand, while flight engineer and right waist gunner take places sitting on floor with hands laced behind their heads. In actual ditching, men would wear chutes to cushion backs against impact. If forced down at sea when winds are below 35 mph., approach and landing is made crosswind and parallel to crests and troughs of swells; in stronger winds, or when no waves exist, ditching is into wind. (AAF Tactical Center photos)

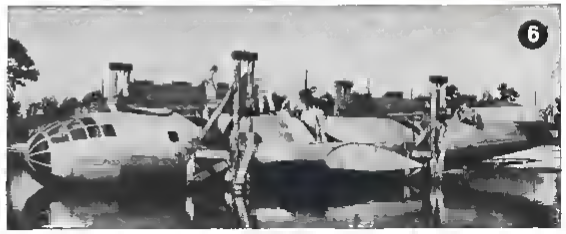
2. Immediately on "landing", commander and pilot unbuckle chutes and exit through cabin's side windows and go to left and right wing, respectively. From nose to tail a B-29 has six emergency exits. No predictions can be made on how long a Superfort will remain afloat. Though AAF records show that one B-29 sank in less than 3 min. after hitting, another one floated for two full days was finally taken in tow by a destroyer, then was dragged ashore to be salvaged.

3. Tail gunner, dubbed "caboose man", leaves his pressurized compartment to join other crew members on left wing. In real forced landing, on order, "Prepare for ditching," crew members would destroy all confidential equipment before plane came down. At interphone command, or single long ring on alarm bell, crew braces for impact. Recommended bracing positions on B-29 are: Secured by safety belt and harness; seated, back against a forward bulkhead, hands clasped behind head; or full length with back on floor, feet against a forward bulkhead, knees slightly bent, and hands clasped behind head.

4. Following "landing" impact in water, all crew members follow a well ordered escape routine and head for rubber life rafts. Bombardier and men from four crew stations on right side of plane go to right wing. Upper gunner, tail gunner, and men who ordinarily fly on left side (navigator, radar observer, and commander) go to left wing. Average time for an entire crew to be out of plane and into rubber boats is 1 min., but recently a crew sped through ditching procedure in 45 sec.



5. This is one of two brilliantly colored rubber life rafts each designed to carry six men and emergency equipment. Rafts automatically leave compartments atop fuselage and bounce onto wings fully inflated. If each man does his job properly, raft will be carrying flares, short-wave radio, sea marker powder, water, food, fishing equipment, and other supplies to sustain men until rescue is effected. AAF states that these light boats can withstand even severe storms.



6. Automatically inflated life rafts pop from special compartments on either side of fuselage. Seen here full length, bomber mockup was made specially by Boeing for AAF visual training program. It is mounted on wooden framework and "dunked" by means of four hydraulically operated jacks. It is also used to train instructors (designated as personal equipment officers) in art of imparting this knowledge to B-29 crews.

7. Practice ditching of B-29 mock up completed, a full crew rows away in rubber boats. Missions from B-29 bases in Marianas to Japan usually require more than 14-hr. flying over lonely stretches of water, therefore ditching drill has become a top priority assignment for Superfort men. Practice like this helps to prevent confusion and delay in event of an actual emergency landing and helps morale of combat crews.

Physical and Electrical Properties Of Beryllium-Copper Alloys

Beryleo 225C is recommended for applications where higher hardness is required than in 20C. It is used for safety tools with cutting edge.

Physical Properties

Tensile strength	110,000 to 165,000 psi
Yield strength	90,000 to 140,000 psi
Hardness	Rockwell C-25 to C-44
Elongation in 2 in.	1% to 3%
Electrical conductivity	25% IACS
Tension impact	4 to 12 ft. lb.
Density	0.290 lb./cu. in.
Heat conductivity	Same as electrical conductivity

Beryleo 275C is hardest alloy for dies and plastic mold applications but does not have ductility and impact resistance of 20C. It can be hardened to Rockwell C 45 or better.

Physical Properties

Tensile strength	125,000 to 170,000 psi
Yield strength	110,000 to 145,000 psi
Hardness	Rockwell C 35 to C 46
Elongation in 2 in.	1% to 2%
Electrical conductivity	25% IACS
Tension impact	3 to 9 ft. lb.
Density	0.292 lb./cu. in.
Heat conductivity	Same as electrical conductivity

Beryleo 20C is a high strength alloy which can be heat treated to high hardness and tensile strength. It is employed for parts requiring impact and corrosion resistance with good wearing properties.

Physical Properties

Tensile strength	110,000 to 160,000 psi
Yield strength	95,000 to 140,000 psi
Hardness	Rockwell C-25 to C-44
Elongation in 2 in.	1% to 2%
Electrical conductivity	25% IACS
Tension impact	3 to 9 ft. lb.
Density	0.292 lb./cu. in.
Heat conductivity	Same as electrical conductivity

Beryleo 50C has high electrical and thermal conductivity with somewhat lower hardness and tensile strength than 20C. It is recommended for refrigeration, electrical, and similar applications.

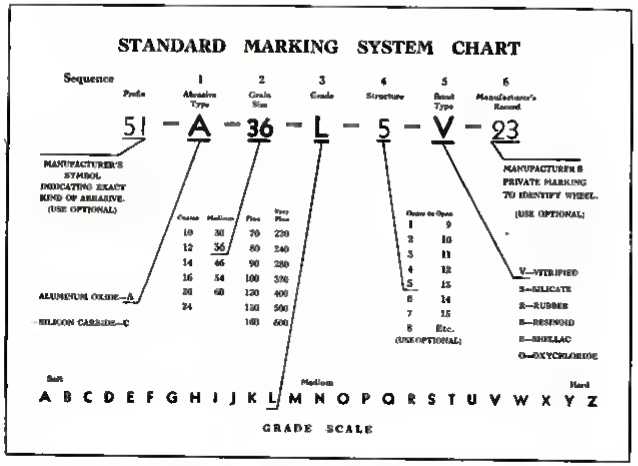
Physical Properties

Tensile strength	90,000 to 100,000 psi
Yield strength	70,000 to 80,000 psi
Hardness	Rockwell B 90 to B 95
Elongation in 2 in.	6% to 8%
Electrical conductivity	50% to 60% IACS
Density	0.311 lb./cu. in.

(Courtesy Beryllium Corp. of Pa.)

SHEET NUMBER D-28
CLASSIFICATION . . . . . Materials
SUB CLASSIFICATION . . . . . Grinding Wheel Standards

Identification Standards Of Grinding Wheel Manufacturers Assn.



New system for identifying grinding wheels and other bonded abrasives uses the system shown below. Prefix at left of line is optional and is for manufacturer to use for his own symbol or brand name. Sequence 6 (right) is for manufacturer's identification mark for private or factory records. Where standard markings differ materially from old form, it may be advisable to use both old and new methods for an introductory period, thus to enable users to become accustomed to the new markings.

(Courtesy Grinding Wheel Manufacturers Assn.)

How T.W.A. "Points the Way" to Finer Air Transportation

Science Searches for New Methods— New Materials for Speedier, Safer, Better Flying

Pointing the way to broader horizons for air transportation, T.W.A. scientists are constantly at work behind the scenes. They check and regulate the most delicate mechanism. They find ways to improve and make even more efficient the latest in aviation equipment. It is their job, too, to discover new refinements to make present T.W.A. airliners better and to speed the way to the greater, more luxurious airliners of the future.

An example of the search of science for a higher level of efficiency is the work of William Enbrecht, T.W.A. master mechanic. Here he examines an altimeter in T.W.A.'s instrument shop in Kansas City. The work of scores of skilled T.W.A. technicians points the way to finer air transportation. It is the "inside story" of a great airline.

DRAWING BOARD BIRTH OF AN AIRPLANE—Working in closest cooperation with airplane manufacturers, T.W.A. draftsmen lay out the basic concept of a four-engined transport.

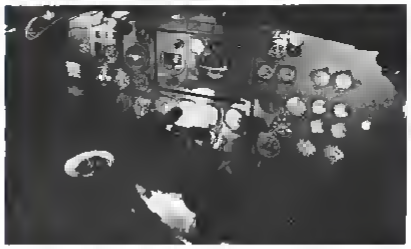
Listen to "Science Looks Forward"—new series of talks by the great scientists of America—on the Philharmonic Symphony Program CBS network, Sunday afternoon 3:00 to 4:30 E.W.T.

PLANNERS—To the last detail of convenience and efficiency, T.W.A. planners Joseph Hawkins and Glenn Scott draft plans for efficient buffet design.

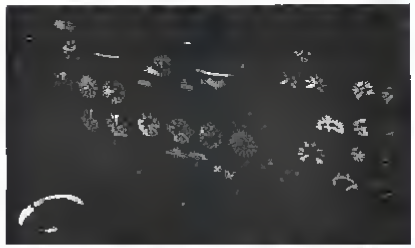
TESTERS—Aerodynamist George C. Prill takes readings on a recording thermometer—checking cylinder head and air temperatures.

COMFORT ENGINEERS—To assure the utmost in passenger comfort, T.W.A. engineers Luther Hoffman and E. J. Mills work out a seating arrangement in a cabin mock-up.

TEST PILOTS—Every new addition to a T.W.A. airliner is flight tested—contributing to the safety and dependability of today's air service. Here, Engineering Pilot Jack B. LeClaire takes a plane aloft for test.



LIGHTING PROJECT...Before—An example of T.W.A. progress toward perfection is this lighting project. Here lighting on the instruments causes glare—interferes with the pilot's night vision of outside objects.

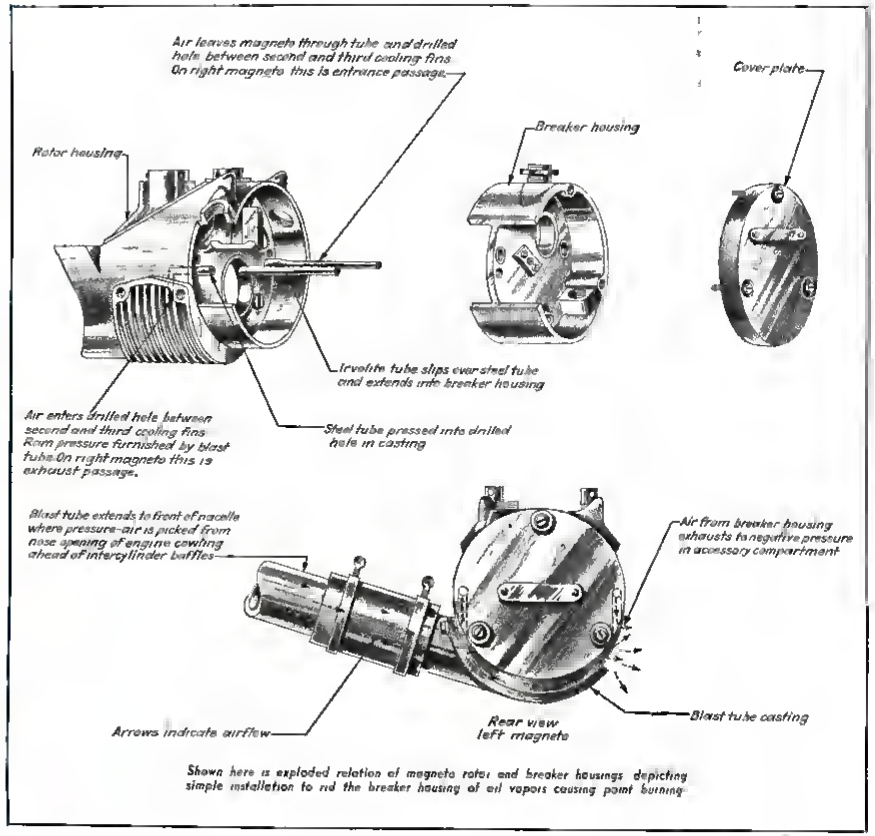


LIGHTING PROJECT...After—T.W.A. engineers developed "black light" now used throughout the T.W.A. fleet. Dials and pointers are clearly illumineted, glare is eliminated and night flying visibility improved.

Ventilation of Breaker Housing Saves Magneto Points

To rid the magneto breaker housing of combustible oil vapors causing burning of breaker points, Chicago & Southern Air Lines engineers devised a simple method for ventilating this vital part of the magneto system. Utilizing the difference between magneto blast tube pressure and reduced cowl pressure to produce airflow, circulation was effectively applied by drilling holes in the rotor housing from between cooling ribs on opposite sides of the casting.

As shown in the accompanying illustration, air is led from one of the holes into the breaker housing through an Irvolite tube slipped over a short length of steel tube pressed into the hole. The opposite hole serves as an outlet to the cowl and draws off oil vapors from the breaker housing. A series of inspections over several engine overhaul periods showed no burning of the points.



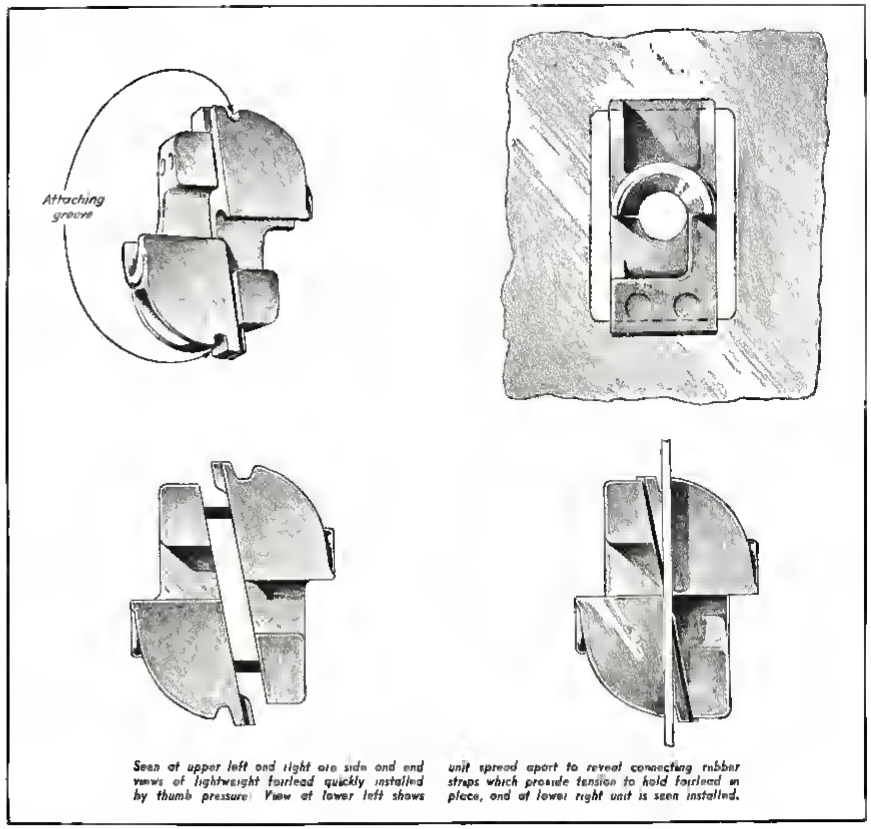
Shown here is exploded relation of magneto rotor and breaker housings depicting simple installation to rid the breaker housing of oil vapors causing point burning.

Novel Lightweight Fairlead Is "Snap" to Install

LIGHTWEIGHT CONSTRUCTION and rapidity of installation are featured in a simple plastic fairlead developed by Cycle-Weld Div. of Chrysler Corp.

Weighing but five grams, the fairlead—commercially designated Snap-Lead — consists of symmetrically shaped opposed halves held together by two small strips of rubber providing an elastic grip when the device is inserted in the bulkhead opening. These strips —⅛ in. wide, about ⅛ in. thick, and ¼ in. long—are fixed to the fairlead at opposite points by a cement-binding process known as Cycle-Weld. The new device can be installed in 10 to 30 sec.

The control cable is inserted through openings provided on one side of the fairlead while the rubber strips are relaxed, and by applying firm thumb pressure, the fairlead is snapped into the supporting panel opening. Two small groves on top and bottom of the fairlead fit the edges of the panel opening, and tension set up by the rubber strips holds the device in place. Cable-passage openings are either 7/16 or ½ in., and belled surfaces at each mouth minimize cable friction. Length of the installed unit is 1 7/16 in., width is 3/8 in., and thickness ½ in.

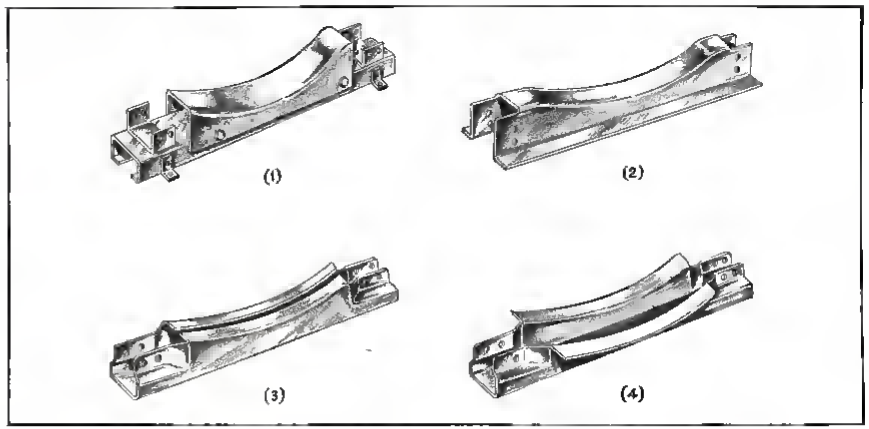


Seen at upper left and right are side and end views of lightweight fairlead quickly installed by thumb pressure. View at lower left shows unit spread apart to reveal connecting rubber straps which provide tension to hold fairlead in place, and at lower right unit is seen installed.

Design Evolution Simplifies Tank Bracket

How the design of even one of the simplest of aircraft parts—an oxygen tank bracket—can be improved, is shown in the accompanying illustration. Recently required for Convair bombers, the original engineering design of the bracket (1) was rejected by tooling and production groups because its fabrication and assembly would necessitate an excessive use of time and tools. A vastly simplified design (2), suggested by production experts because it could be fabricated simply from a single sheet of dural, was rejected by engineering because it was not properly stressed.

Design shown at (3) was suggested by tool engineers on the basis that it would incorporate the best features of the first two designs. The latter design was approved for actual production, but subsequent experiences revealed that the inturned bracket lips made fabrication difficult. It was then decided to turn the bracket lips outward, as indicated at (4) which shows the tank bracket now being installed

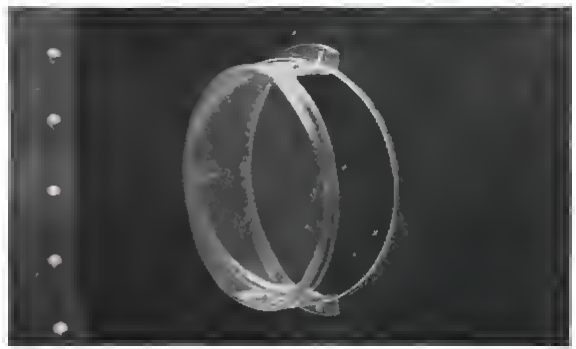


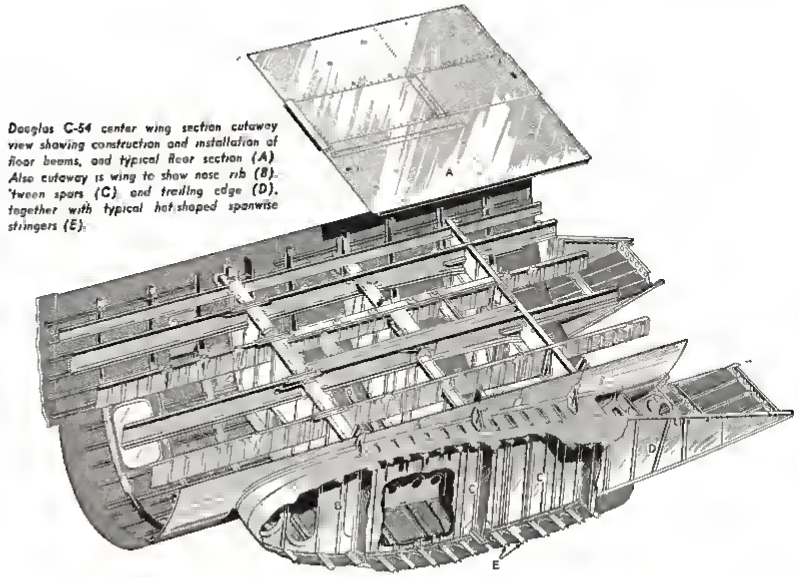
Retractible Plastic Ventilator Doubles For Gunport Closure

Simple cabin ventilator shown here, molded of transparent plastic material and consisting of but two parts, may be closed by retracting flush with retaining surface.

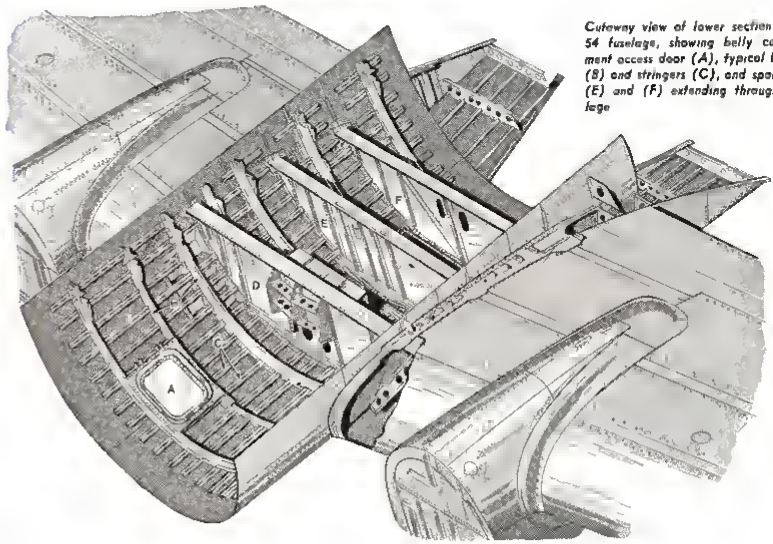
Developed by B. B. Simcox, president of Snapvent Co., the device may be rotated for intake of fresh air or exhaust of cabin air, with adjustment for amount of ventilation desired.

Used on Army aircraft, the unit may be instantly removed to provide 3½ in. opening—standard size for gunports on cargo and transport planes.

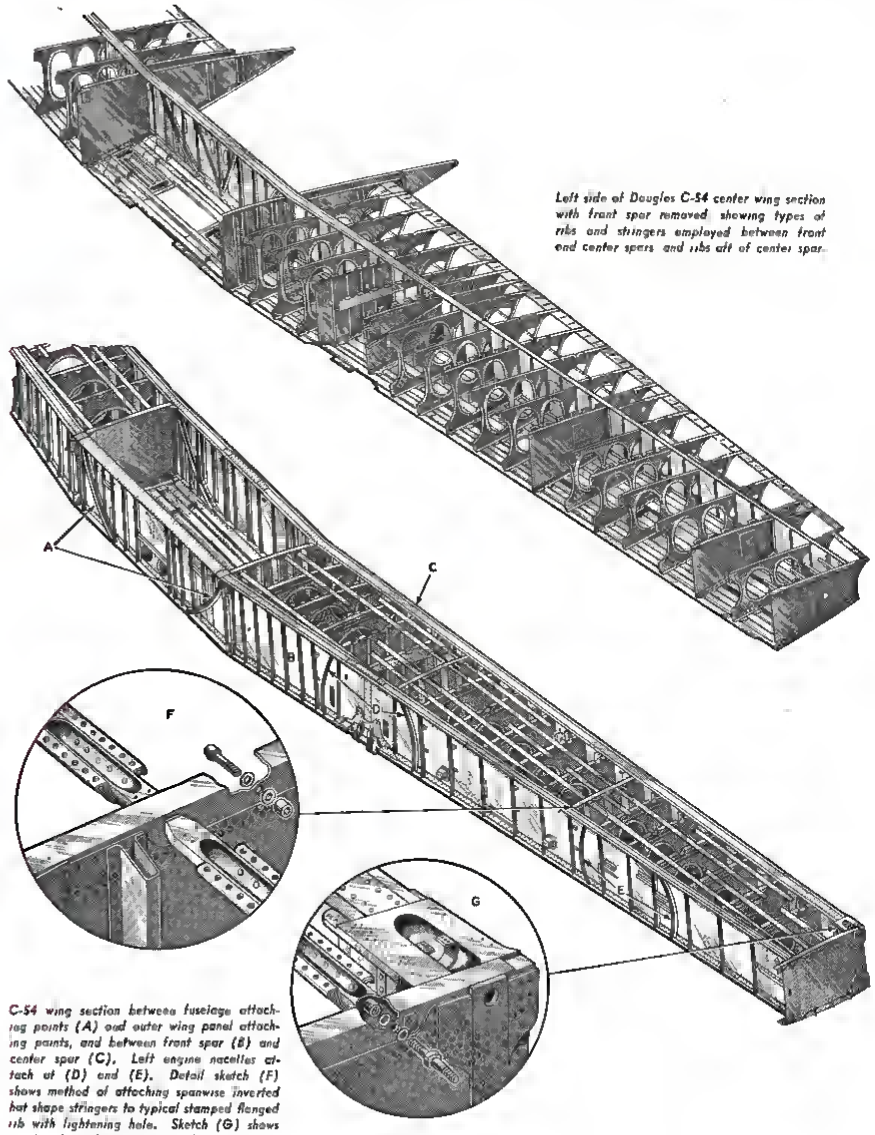




Douglas C-54 center wing section cutaway view showing construction and installation of floor beams, and typical floor section (A). Also cutaway is wing to show nose rib (B), 'tween spars (C) and trailing edge (D), together with typical hat-shaped spanwise stringers (E).

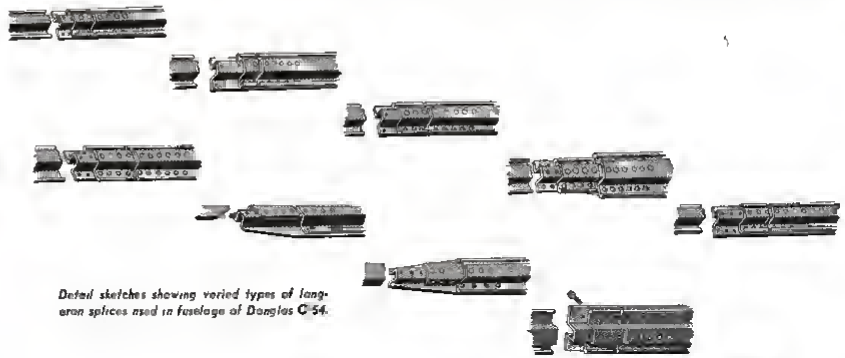


Cutaway view of lower section of C-54 fuselage, showing belly compartment access door (A), typical formers (B) and stringers (C), and spars (D), (E) and (F) extending through fuselage

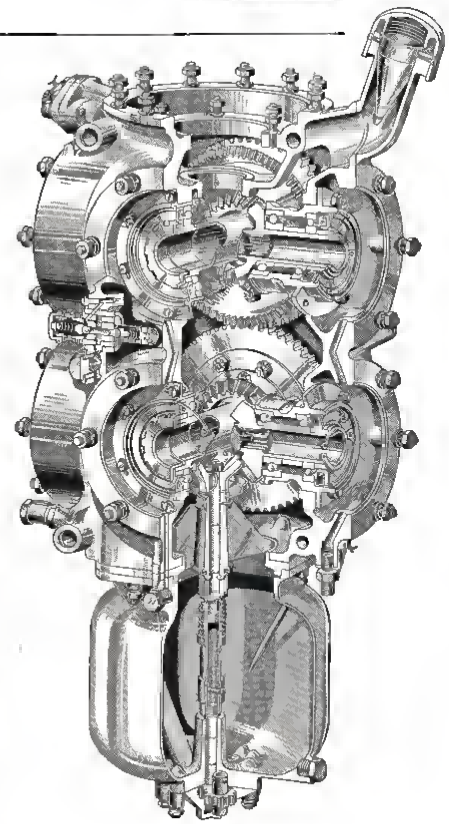


Left side of Douglas C-54 center wing section with front spar removed, showing types of ribs and stringers employed between front and center spars and ribs aft of center spar.

C-54 wing section between fuselage attaching points (A) and outer wing panel attaching points, and between front spar (B) and center spar (C). Left engine nacelles attach at (D) and (E). Detail sketch (F) shows method of attaching spanwise inverted hat shape stringers to typical stamped flanged rib with lightening hole. Sketch (G) shows construction of stringer attachment as well as details of built-up structure at rear spar for attaching outer wing panel.



Detail sketches showing varied types of longeron splices used in fuselage of Douglas C-54.



Cutaway drawing of Rotol, Ltd., 6-drive universal accessory drive gearbox. Two hollow mainshafts are carried in ball bearings in front face (which is attached by 16 studs) and in rear wall of main casing. Toward front of each mainshaft, integral flange is formed, to which are bolted large spur gears, causing shafts to rotate at same speed but in opposite directions. Small bevel gears are also bolted to flanges and upper mainshaft has large bevel gear for driving generator. Shims for mesh adjustments are provided between shafts and front bearings for small bevels and between flange and gear for large bevel. Shafts are located axially in front cover by bearing housings, rear bearings are free to move axially in brass housings. Front and rear bearings are retained on shafts by hollow nuts and hardened steel collars.

Recessed faces in main casing sides are bored to receive four accessory drive groups, in each of which a bevel pinion, integral with hollow shaft is carried in ball bearings in flanged alloy housing. Gear type oil pump is attached to base of bowl shaped alloy sump, oil being delivered from pump through drillings in sump up to compound relief valve consisting of two opposed spring loaded ball valves lifting at different pressures.

Combined oil filler and breather, consisting of cast neck fitted with conical wire gauze filter and spring-loaded bayonet cap, is bolted to top of main casing. On the other side is a cap for screwed banjo plug. Filler and cap can be interchanged to suit installation. Accessories are not driven directly from accessory drives or mainshafts but through drive quills consisting of two concentric sleeves pinned together. Seizure of an accessory shears pin and localizes damage.

SIDE SLIPS

WE JUST received a handout announcing formation of the aeronautical company to end all companies. Signed by the vice-president, publicity division, it calls this now-being-born organization "a structure designed to fill the needs of the aircraft industry in every aspect of its many ramifications except manufacturing and airline operation," concluding that "the time is ripe. Let us grasp opportunity by the throttle and with full flaps, zoom into the limitless sky."

Can we leave our landing gear down?

• Last January we printed a rhymed plea from a Canadian worker who asked that the next set of Lancaster drawings he sent from England "complete with one lorgnette" so the prints could be read. Here, signed by "just a poor blind draftsman" over in Britain, is the rhythmic reply.

To you Canadian workers
Out there across the sea,
We thank you for your invite,
And will take that cup of tea

W're glad to see your lenience,
O'er our distressing rules,
But we haven't made the system,
We're just the system's tools

We suffer through these strokes and things
Almost as much as you,
It takes us nearly eighteen months
To learn just what to do

And as for wearing glasses
When our sight goes, you know
We use imagination,
Why don't you chaps have a go?

You've made some record breakers
By using it o'er there,
Tho' we guess you've broken other things,
Gnashed teeth and torn your hair

We've drawn in fog and blackout,
By night as well as day
And if we'd waited for the light,
We'd be saying 'Heil' today

So remember when you're angry
And you're spoiling for a fight,
To mix pity with your censure,
For we *never* see the light

Gentlemen, may we make it three over that cup of tea so we can tell you it's more than swell that you can—with neither light nor lorgnettes—build a lot of darn good airplanes and still keep a sense of humor.

• When the dreamers start asking why airplanes can't be sold for $298 we might cite this one tiny example of the work necessary to make 'em good before you make 'em cheap:

In describing a change on a simple bracket, a friend writes that "the original engineering design was rejected by tooling and production groups because its fabrication and assembly would necessitate an excessive use of time and tools.

Then there came "a vastly simplified design suggested by production experts because it could be fabricated simply from a single sheet of dural, but was rejected by engineering because it was not properly stressed." Next came a design "suggested by tool engineers on the grounds that it would incorporate the best features of the first two designs.

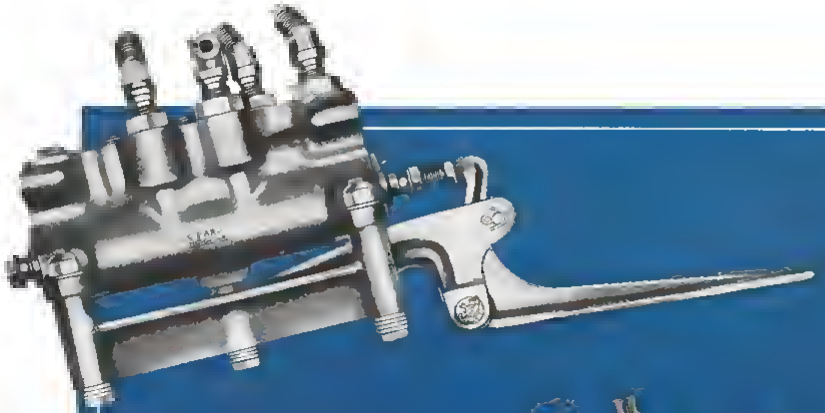
The latter design was finally approved for actual production, but subsequent experience revealed that the inturned bracket lips made fabrication difficult, so it was decided to turn the bracket lips outward."

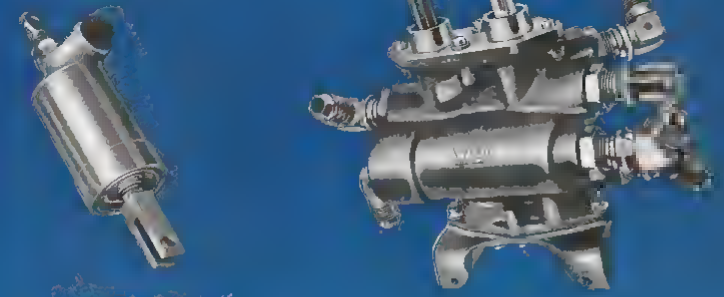
• A house organ editor's note reports that "news stories from the South Pacific show South Sea Islanders sawing dropped gas tanks in two for outrigger canoes. With slight modifications, these tanks can be fitted out for postwar use in the United States."

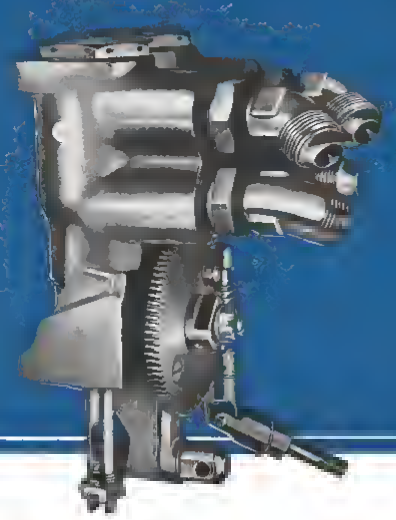
To which our marketing man says: "Well, there's *one* surplus problem the aviation industry has been able to drop in somebody else's lap."

'Maguire says if they're going to teach the earth's small fry to fly, WE'D better learn to walk.'

VARD Hydraulics





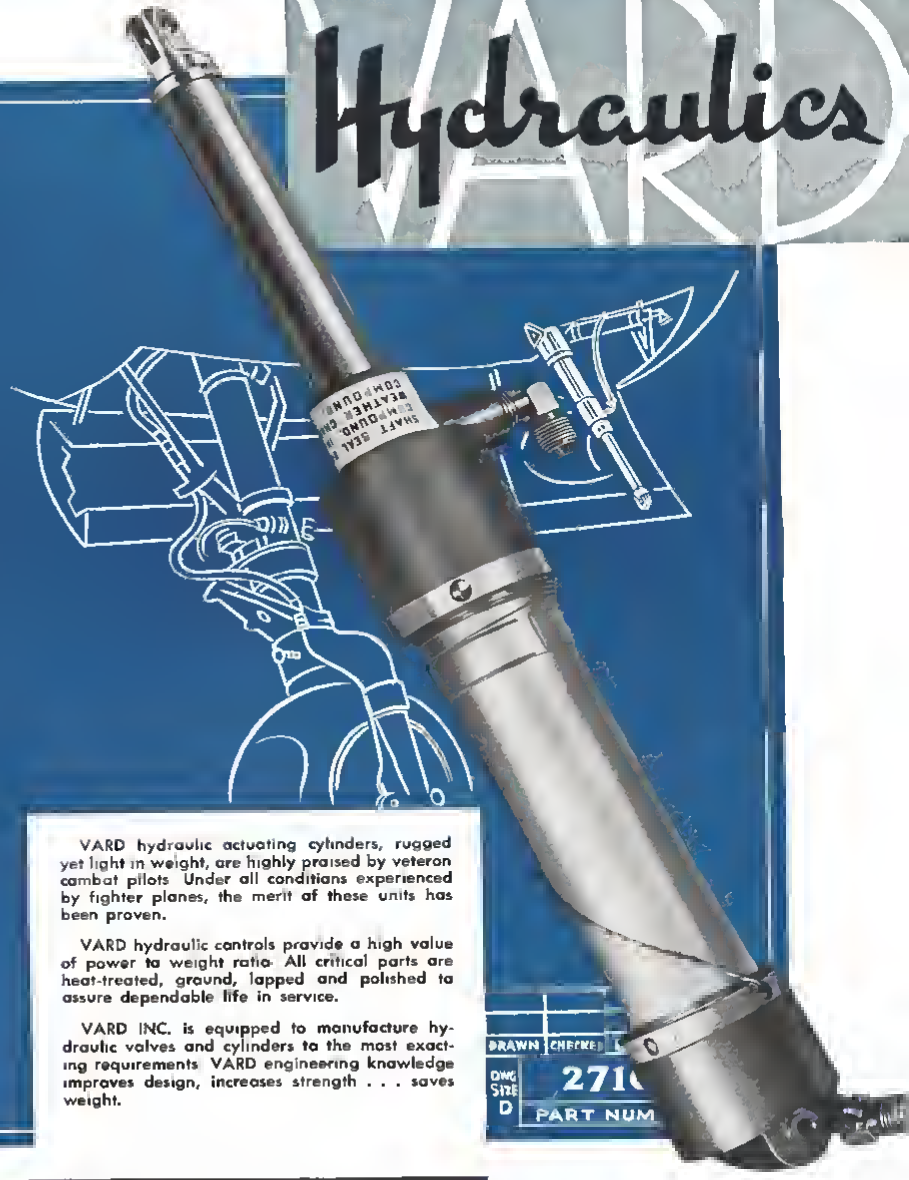


VARD INC. manufactures hydraulic units complete from castings to smallest machined parts.

Illustrated here are four aircraft hydraulic units; an uplock cylinder, two hydraulic control valves and a flap stop valve.

VARD INC. has produced large quantities of these units on reasonably short schedules.

These units are indicative of fine performance obtainable with VARD hydraulic equipment.



VARD hydraulic actuating cylinders, rugged yet light in weight, are highly praised by veteron combat pilots. Under all conditions experienced by fighter planes, the merit of these units has been proven.

VARD hydraulic controls provide a high value of power to weight ratio. All critical parts are heat-treated, ground, lapped and polished to assure dependable life in service.

VARD INC. is equipped to manufacture hydraulic valves and cylinders to the most exacting requirements. VARD engineering knowledge improves design, increases strength . . . saves weight.

DRAWN CHECKED
SIZE D
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PART NUM

ARMY E NAVY

VARD INC.
PASADENA 8, CALIF.

REVIEW OF PATENTS

By A. HARRY CROWELL *Registered Patent Lawyer*

FOLLOWING are digests of some of the more interesting recent patents on aviation developments granted by the U S Patent Office Mr Crowell will gladly furnish readers with free information on approximate cost and procedure in applying for patents and trademark registration. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York City (18) Printed copies of any of patents listed are obtainable at a cost of 10c each, directly from U. S. Patent Office, Washington.

Rotary Wing Mounting, intended to eliminate build-up of resonance conditions, provides means for restraining lag-lead movements of blades about drag hinges during driving of rotor in preparation for takeoff.—2,370,127, filed Sept. 8, '41, pat. Feb 27, '45, R G Andersen, assignor to Autogiro Co. of America.

Landing Wheel Spinner, for rotating wheels in forward direction to reduce frictional resistance between wheels and ground during landing operation includes casing and fixed guide blades to direct airstream to impeller blades tangentially to circumference of impeller.—2,370,310 filed Nov 28, '42, pat Feb 27, '45, S N Juni, assignor to Briggs Mfg. Co.

Releasable Load Compartment for enclosing and carrying bombs is designed to improve bomb-sighting by coordinating actual dropping of bombs with rapid opening of bomb doors and eliminate usual delay necessitated by slowing and stabilizing plane incident to opening of doors. As bomb is dropped, its weight is exerted downwardly and outwardly against arm-link units which slide along and rotate about pins while doors are opened and automatically closed.—2,370,382 filed Oct. 25, '40, pat Feb 27 '45, T. P. Hall assignor to Consolidated Vultee Aircraft Corp.

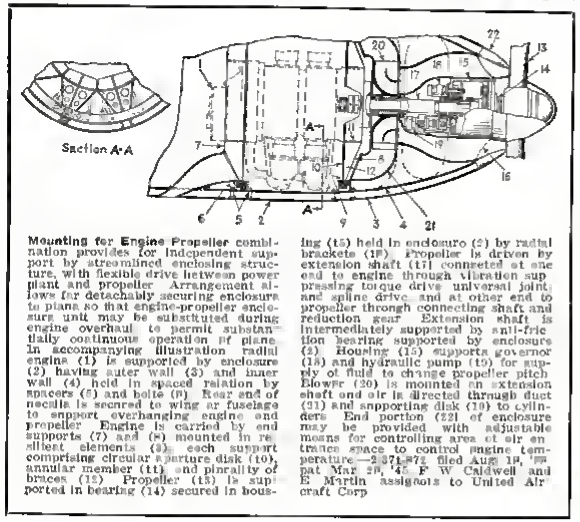
Adjustable Mount for support of gun in relatively thin wing without usual projection of mounting elements outside wing contour embodies releasable locking device to facilitate gun removal and also to hold gun effectively with wedging action against vibration.—2,371,004, filed Oct 8, '40, pat Mar 6, '45 M. S. Untermen assignor to Republic Aviation Corp.

Avigational Method and Apparatus includes means for adjustment and control of conventional compass and driftsight in combination and is designed to simplify operation of following predetermined compass course with respect to terrestrial poles of earth, regardless of conditions which may involve wind direction not parallel to compass course. Driftsight includes aerial mapping camera of reflex type the reflex mechanism incorporating driftsight as integral part of camera in conjunction with means for viewing earth object.—2,370,999, filed Oct. 3, '39, pat. Mar. 6, '45, W T. Jochum.

Control Mechanism of boost tab type is characterized by small force applied to actuating lever to effect deflection of control surface, boost tab being controlled by linkage to deflect it angularly to direct proportion to spring deflection in response to shift of actuating element. Stop screws may be adjusted so that, at desired acceleration of plane, they will prevent tab from giving further aid in reducing hinge moment of control surface.—2,370,844, filed Jan 29 '43, pat Mar. 6, '45 F W. Davis assignor to Consolidated Vultee Aircraft Corp.

Wing Structure designed to obtain most favorable disposition of useful load with respect to center of gravity, while employing fuselage of minimum height, has inboard or fuselage-enclosed parts of primary load carrying elements disposed in front of center of gravity and inner portions of leading margins of side parts of structure extending rearwardly at acute

(Turn to page 272)



Mounting for Engine Propeller combination provides for independent support by streamlined enclosing structure, with flexible drive between power plant and propeller. Arrangement allows for detachably securing enclosure to plane so that engine-propeller enclosure unit may be substituted during engine overhaul to permit substantially continuous operation of plane. In accompanying illustration radial engine (1) is supported by enclosure (2) having outer wall (3) and inner wall (4) held in spaced relation by spacers (5) and bolts (6). Rear end of nacelle is secured to wing or fuselage to support overhanging engine and propeller. Engine is carried by end supports (7) and (8) mounted in resilient elements (9), each support comprising circular aperture disk (10), annular member (11), and plurality of braces (12). Propeller (18) is supported in bearing (14) secured in housing (15) held in enclosure (2) by radial brackets (16). Propeller is driven by extension shaft (17) connected at one end to engine through vibration suppressing torque drive universal joint and spline drive, and at other end to propeller through connecting shaft and reduction gear. Extension shaft is intermediately supported by anti-friction bearing supported by enclosure (2). Housing (15) supports governor (18) and hydraulic pump (19) for supply of fluid to change propeller pitch. Blower (20) is mounted on extension shaft and air is directed through duct (21) and supporting disk (10) to cylinders. End portion (22) of enclosure may be provided with adjustable means for controlling area of air entrance space to control engine temperature.—2,371,572 filed Aug 18, '43 pat Mar 20, '45 F W Caldwell and E Martin assignors to United Aircraft Corp.

Book Reviews

STEAM AND GAS TURBINES, Vol 1 and 2. By Dr A Stodola. Peter Smith, New York City. McGraw-Hill Book Co., New York City. 1,356 pages, text, illustrations, charts, index. $20.00.

Authorized translation from the sixth German edition this book considers features and phases of steam and gas turbines and includes theoretical, experimental and constructive factors. The work is highly detailed and well illustrated.

THEORY OF FLIGHT, by Richard von Mises. McGraw-Hill Book Co., New York City. 629 pages, text, charts, index. $6.00.

Written with the collaboration of Prof. W. Frazer and Gustav Kuerti, this volume treats theory of aircraft flight with presupposition that reader has knowledge of standard college mathematics and some familiarity with general mechanics. For all main subjects numerical examples are offered and worked out in the context. Included also are 220 parallel problems, arranged in order of difficulty.

AVIATION RADIO, by Henry W. Roberts. William Morrow & Co., New York City. 637 pages, text, charts, illustrations, index. $5.00.

Fully detailed and illustrated discussion of aviation radio and its fundamental principles, primary and advanced radio facilities, radio aviation and the design and installation of radio apparatus. Included is an introduction by Dr. Lee de Forest, inventor of the radio vacuum tube.

DEMONSTRATIONS AND LABORATORY EXPERIENCES IN THE SCIENCE OF AERONAUTICS. McGraw-Hill Book Co., New York City. 155 pages, text, illustrations, graphs, charts, index. $2.00.

Prepared with the cooperation of the CAA and the American Council on Education, this book is a key guide for teachers and students interested in making and using classroom demonstration apparatus and materials for the purpose of illustrating the principles of aeronautics.

AIR NAVIGATION, Part Six, Contact Flying. McGraw-Hill Book Co., New York City. 182 pages, text, illustrations, maps, charts. $2.50.

Covered here in the sixth part of the Navy-supervised flight preparation training series are the elements of contact navigation (directing of an airplane to its destination by reference to visible landmarks). Included is a discussion on flight technique, aviation procedure and map reading, and outlined are CAA regulations governing cross-country flights within the United States.

ROCKETS AND JETS, by Herbert S. Zim. Harcourt, Brace & Co., New York City. 326 pages, text, illustrations, appendix, index. $3.00.

Exposition of facts and fundamentals of rocket and jet engines, and of rocket weapons of war.

GROUND INSTRUCTOR RATING, by Charles A. Zweng. Pan American Navigation Service, Hollywood, Calif. 192 pages, illustrations, glossary, index. $3.00.

This third revised edition features revision and enlargement of chapter titled, "Methods of Instruction and Class Work." Remainder of text covers principal subjects on which applicants for ground in-

(Turn to page 273)

THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington — HERB POWELL, New York

Criticism Rises Over Surplus Craft Disposal; Transfer to Department of Commerce Mooted

. . . Cadet program cut . . . License exam questions drafted by medic panel . . . N-S regulation maneuvers scrutinized by NATA . . . Civil lightplane production seen okayed soon . . . McCarran airport bill reported favorably . . . Westinghouse jet plant in production stage.

RFC's methods of disposing war surplus aircraft has caused considerable criticism, and at this writing a Congressional investigation by the Senate's Mead War Investigation Committee is threatened. There is talk also of transferring surplus warplane disposal to the Department of Commerce, where the CAA would have a hand in it.

Complaints against the airplane disposal program have been building up for weeks. The Surplus Property Board, which makes surplus disposal policy while in the case of airplanes, RFC carries it out, has failed to issue expected aircraft disposal regulations. In the press and elsewhere RFC is charged with failing to state in advertisements that airplanes for sale are not in condition for certification. Aviation Trades Assn., National Aeronautic Assn., and other interested parties, oppose direct sales by the government, favoring instead distribution through regular aircraft service operators.

Many persons in the aircraft industry fear that promoted sales of training planes many unsuitable for non-military work will result in decreased acceptance when new designs are offered. Of 3 000 surplus primary trainers offered nearly 1 000 have been sold at an averaged tagged price of $1,100. Also offered are 2 700 two-engined cabin monoplanes and 3 700 Vultee single-engined basic instrument trainers at $3,500 to $5,500. Also 1 070 gliders are being declared for sale.

Cadet Program Cut; Last Nine Civil Schools Out

As hostilities came to a close in Europe War Department announced drastic reduction in its cadet program, the curtailment mainly affecting pre-air cadets, crew trainees, and inactive members of the enlisted reserve. Statement was that those already in training would be enough to meet future demands for pilots, bombardiers, and avigators.

Accordingly termination of contracts with the nine remaining civilian schools was announced, to be effective around August. Schools were: Carlstrom Field, Arcadia, Fla. (Embry-Riddle Company); Curtis Field, Brady, Tex. (Brady Aviation School, Ltd.); Wilson-Bonfils Flying School, Chickasha, Okla.; Thunderbird Field No. I, Glendale, Ariz.; Lodwick School of Aeronautics, Inc., Lakeland, Fla.; War Eagle Field, Lancaster, Calif. (Mira-Loma Flight Academy); Rankin Aeronautical Academy, Tulare, Calif.; Garner Field, Uvalde, Tex. (Hangar Six, Inc.); and Hawthorne School of Aeronautics, Orangeburg, S. C.

Tabulation of the AAF training command record showed that 224,331 pilots had been graduated in period from 1939 through Mar. 1945, while avigators totaled 46,121, bombardiers 42,095, and aerial gunners 282,836.

License Exam Questions Drafted by Medic Panel

Following announcement by T. P. Wright, CAA administrator, that any competent licensed physician is authorized to give medical examination for private pilots beginning June 1, a five-man panel of eminent physicians has been formed to draft a set of simple questions to be followed by doctors in examining applications for student and pilot licenses.

The panel was selected by National Aeronautic Assn., which was studying the problem before CAA's announcement of the liberalized medical program. NAA and many other authorities believe physical exam procedures have been outmoded with time. Questions proposed by the medical panel will be submitted to CAA.

Notes on CAR Revisions

Revisions of Parts 20, 60, 43 and 45 of the Civil Air Regulations will become operative July 1. In adopting liberalized regulations, which were submitted by the CAB Safety Bureau, the Board reminded all students and pilots that their responsibility for raising the safety record is increased. Obviously the Board means that public opinion will compel tighter rules if there are too many accidents.

Changes in CAR set 17 as the minimum private pilot age; avigation and meteorology are dropped from written quiz; private certificate calls for 10 hr. dual, and some glider time will be counted for powered rating.

HOLE IN ONE

. . . But it didn't score a win for the German. For despite this unique potshot through one blade of Republic Thunderbolt's Curtiss hollow steel prop, the good old P-47 returned safely to base. Football-size puncture is believed to have been made by a Nazi fighter plane's 40-mm cannon. Although he was sure his craft had been hit, pilot remained mystified until he landed, because he could see no damage on plane. He reported that he felt no appreciable difference in P-47's performance except for a slight roughness.

N-S Regulation Maneuvers Scrutinized by NATA

What CAB's next step might be toward regulation of non-scheduled carriers, following recent hearings, could not be predicted. National Aviation Trades Assn., which is heavily interested, suggests that CAB could (a) ask for additional testimony, (b) request briefs be filed, (c) reopen original hearings, (d) have examiners submit an additional report to the Board.

In his acceptance of safety regulation for N-S operators, and his rejection of any economic and route restriction, Roscoe Turner, president of NATA, apparently is supported by NAA Personal Aircraft Council of the Aero Chamber, Feeder Airline Assn., State Aviation Officials, and several other groups. Generally, the air transport industry seemed unconcerned, except for United and American,

Coming Up

(Meetings and dates subject to wartime conditions under ODT regulations)

June 2: Interhemisphere conference on frequency allocations and revisions, Rio de Janeiro.

June 7-9: Aviation Writers Assn. Annual Conference, Chicago.

Aug. 16-17: IAS Los Angeles Meeting.

Oct. 2-6: IAS Air Transport Meeting, Washington, D. C.

Oct. 4-5: IAS Light Aircraft Meeting, Detroit.

Oct. 31-Nov. 2: 1945 National Aviation Clinic, Oklahoma City. (Pre-clinic conferences start Oct. 27.)

Nov. 15: IAS Engine & Accessories Meeting, Dayton.

Dec. 17: IAS Wright Brothers Lecture, Washington, D. C.

Note: SAE local meetings (being arranged following cancellation of national gathering) will be held in New York, Detroit, Buffalo, Dayton and Kansas City on dates to be announced.

which proposed various degrees of regulation for N-S aviation.

CAB examiners in charge of the hearings were William J. Madden and Curtis C Henderson

Civil Lightplane Production Seen Okayed Soon

Industry observers expect that Henry P Nelson, director of WPB's Aircraft Division, soon will obtain modification of Order L-48 thus permitting lightplane builders to start civil production with war-released materials and manpower. Opinion is that a limited number of new designs could be on the market this fall.

CAA's report that 25,000 military pilots, mostly still in service, have been certificated in the past five months, is creating optimism re the lightplane demand. Total certificated pilots, as of Mar 1945, was over 142 000

But those who remember the previous lightplane boom, of 1928-30, will wait and see whether airport utility, and factors of safety, price, and economy will meet demands. Many potential prospects will wait for later models, many will wait for helicopters.

Incidentally, CAA's chances of getting $150 000 from Congress to experiment with castering wheels, for cross-wind landings, are much improved

McCarran Airport Bill Reported Favorably

Senator Pat McCarran's bill authorizing $100 million a year for five years' airport construction has been favorably reported to the Senate by the Commerce Committee This bill emerges ahead of others in the upper chamber as the instrument of the Administration's plan to match funds with local governments for 3000 new airports which would bring the country's total to over 6,000

The measure as approved provides that the State program be in Class 3 or smaller ports, and that urban fields be Class 4 or larger, using not more than 35 percent of the federal funds. State and city representatives are battling around the 35 percent division line.

At this writing the House Interstate and Foreign Commerce Committee had scheduled a meeting to decide whether to split the airports section off of Rep Clarence Lea's omnibus bill which would revise the Civil Aeronautics Act in several particulars. Indications were that the Lea airport section would be passed by the House and matched up by agreement with the McCarran bill Conclusive action is likely this

B-29 GETS "IN LINES"

Latest variation of famed Boeing Superfort is this model, designated XB 39, powered by four in line liquid cooled Allison V 3420 engines. Named "Spirit of Lincoln", refitted craft was first B 29 to roll off Wichita plant's production lines. ATSC designated new power plants so tests could be conducted to demonstrate feasibility of these engines for heavy bombers. Each Allison develops 2 600 hp on takeoff—making total of 10,400 hp, as compared with 2 800 hp for radial-engined B-29. (ATSC photo)

summer or fall. NAA is making a survey of State and City funds available for matching with federal money.

Westinghouse Jet Plant In Production Stage

Developments in the gas turbine field were highlighted during the month by word that Westinghouse Electric Corp's new Aviation Gas Turbine Div, had now gone from the pilot stage to the production stage. Formation of this division, which works with the Navy, was initially announced in March. It is located at Westinghouse's South Philadelphia Works, and George A Woodard is manager.

Meantime, a study of comparative potentials of gas-turbine craft, authored by C D Flagle, division design engineer, and F W Godsey, Jr., Westinghouse New Products Div manager, was released in New York (This paper is presented on page 131 of this issue.)

★ SPOT CHECKING ★

A $2,500,000 cooperative wind tunnel, financed by Convair, Douglas, Lockheed and North American and to be operated by California Institute of Technology, has been dedicated at Pasadena. Some of the tunnel's notable features are A decompression sphere which permits access to model being tested without disturbing air in tunnel's main airstream temperature inside tunnel. A television unit is to be installed to permit operating engineers to observe model tests. There are two power units one of 10,000 hp., and one 7,800 hp. A duplicate of this tunnel will soon be put into operation by C-W at Buffalo.

United Aircraft reveals that P&W is tooling to build Westinghouse designed gas turbines for U. S. Navy and in addition is negotiating Navy contracts to experiment with gas turbines of company's own design.

Recent introductory international air shipment was flown by AA airfreighter from LaGuardia Field to Mexico City. Shippers were: Colyn Ltd, E R. Squibb & Co Federal Telephone & Radio Corp., International Telephone & Telegraph Co., Office of Inter American Affairs John B. Stetson Co., and Wyeth, Inc.

Republic announces order from Army for modified version of its postwar Seabee amphibian. Craft would be used for sea rescue work in Pacific. Suitability of plane for such work was recently noted when Designer Alex H Spencer employed his amphib in saving a Navy pilot from Great South Bay following a collision of fighter planes.

Erroneous statements giving misconception that 2,000-mph jet jobs are under wind tunnel test have been refuted in a special NACA release. Committee Secretary John F Victory is quoted as "emphasizing that aeronautical science has not yet achieved speed in level flight of as much as 600 mph.

Continental has disclosed production of 2-100-hp skypower engine. Designated as L-1430, plant is a 12-cyl. 60-deg inverted-V type weighing 1,540 lb. Cylinders of the engine are made individually instead of being cast en bloc.

Technical documents drafted at Chicago Conference are currently being shaped into final form by U. S. committees of Provisional International Civil Aviation Organization. Later State Department will transmit U. S. recommendations to other nations for study prior to meeting of Interim Council to be convened in Montreal.

Photo reconnaissance Superfort is designated F-13A. Craft carries six cameras and crew of 10. There is no sacrifice in firepower, and with savings on bomb load, range is greater than B-29s.

A Martin B-26 Marauder has completed 200 missions in European theater. Appropriately named "Flack Bait", craft has been struck by enemy fire more than 900 times, and it had dropped 375 tons of bombs.

Erratum: Through a misunderstanding Col Thomas A Murphy AC was stated (page 210 Apr Aviation) to be, now AAF resident representative at Fulton and Kearnore plants of C-W". Actually, he left this post Mar 26 and is now AAF plant representative at Lockheed Aircraft Corp, Burbank, Calif.

Lead-carrying ability of modern twin engine transports is cited in a C-W release which tells how a Commando transport flew 50 adult passengers out of Manila during liberation emergency. Takeoff was from a highway.

Recommendations for a 10-yr aerial mapping program of California through a cooperative program of Federal and State governments were contained in a report made by State Reconstruction & Reemployment Commission. Stated Col. A. R Heron, State Director of commission: "Full development of California's natural resources in postwar years requires use of modern, aerial mapping methods. Of California's total of 158,693 sq mi, less than one-half is now covered by adequate maps." State would earmark $3,000,000 as its share.

Postwar prospects for large rigid dirigibles were considered in special Goodyear Aircraft Corp presentation in New York City. Cited by company representatives were great range, unusual load-carrying capacity, the fuel economy, and low operating costs of craft. They also pointed to safe wartime operation of lighter-than-air ships in wide ranges of weather conditions. And they noted that development of improved materials promised new achievements in design and capacities of helium-carried craft.

Special program by Shell Oil Co is promoting development of new airports on a national basis, with more than 250 towns already contacted out of a working list of 800. With cooperation of CAA experts, company aviation representatives are explaining requirements and details of construction to community boards, civic groups and planning commissions. Graphic promotion piece employed is a large-format color brochure, **The Airport . . . its Importance to Your Community,** which features section detailing in map form eight steps in airport development.

Publications! Bureau of Transport Economics & Statistics of Interstate Commerce Commission has completed 183-page study of postwar air traffic volume. Predicted is postwar passenger travel five times that of 1941. Report is available from ICC in Washington. Issued by Industrial Research Institute, 60 E. 42nd St, N Y C, is 8-page booklet **Research, Invention and Patents,** an address by Andry A. Potter, Dean of Engineering, Purdue reviewing findings and conclusions of National Patent Planning Commission concerning government patent policies. . . . New PAA color folder **To Magnificent Alaska by Clipper,** invites consideration of Alaska's resources and commerce for postwar potentialities. Feature is map showing types of products and business and their distribution.

ATSC is using floating air depots — Liberty ships fully equipped with machine shops for repair and maintenance of Marianas-based B-29's, known as Aircraft Repair Units (Floating)," ships accomplish fourth echelon maintenance, and they carry helicopters for flying mechanics to otherwise inaccessible spots. Units save time which land-basemen have expended in break camps disassemble equipment crate and box machinery and spare parts ferry material load it on ship and later unload, unpack and reassemble.

★ TAGGING THE BASES ★

Albert L. Zimmerly reports he has been granted a CAA certificate to operate local feeder routes from his Boise base, also a route to Reno.

Following California airports have been opened as private-flight bases: Monrovia Brawley, Carmel Valley Patrick Field (Chico), Corcoran (Corning), Imperial Co. (El Centro), Chandler and Fariona (Fresno), Henderson Field (Ojai), Brackett and Pomona airport, Arlington-Riverside, Rosemead, San Bernadino-Tri City, San Fernando, Reid-Hillview (San Jose), Hancock Field (Santa Maria), Santa Paula, and Santa Susana.

H. W. Wenighal, headquartering at Milwaukee, reports that he is crop-dusting at rate of 60 acres per hour.

Francis Aviation School, Lansing and Flint, Mich., reports that Lansing's Junior C. of C. has formed a very active aviation committee. Gerald C. Francis states he is taking orders for Taylorcraft for future delivery.

At Detroit Municipal Airport Wedell is preparing to re-establish his Ercoupe and Fairchild distributorship as soon as possible.

With three more airlines moving into the administration building, it has been necessary to build a new hangar for service operators.

Otto Aviation, Newark, has leased Staten Island Airport as a metropolitan base for private flyers. Field is of gravel-base and all was added, with 2 sod-fl runways. Same operator recently opened all-year resort at Lake Susquehanna Airport, N. J.

Southern Airways, one of South's larger operators, has completed a reconversion contract with Alaska Airways for three Lockheeds and now is working on Douglas C-47's. Tom D. Eve and Frank Say are supervising work at Atlanta base.

M. B. Johnson, American Aircraft Providence R. I., reports reopening of local fields and states there is greatly increased flight activity.

H. Roscoe Brinton, Embry-Riddle manager at Carlstrom Field, Fla., recently stated that cadet students have flown 45,000,000 air miles there in four years with only one fatality.

★ CANADIAN NOTES ★

By James Manlagnes

A meeting of airline officials from some 30 nations is to take place this autumn at Montreal, according to Maj. J. R. McCrindle executive member International Air Operators Association and deputy director of BOAC.

Canada in recent months sold 116 surplus aircraft, through government-owned War Assets Corp., Montreal. Included were sales to Canadian companies in both air transport and general business and to three United States firms, namely: FAA, Gulf Oil Co. and Chas. H. Babb & Co. In group were 18 Fleet Cornell trainers, Stinson transports, Grumman Goose amphibians (which averaged $23,600 each), Hudson bombers (averaged $10,000 each), Lockheed transports (averaged $14,600 each), Cessna Cranes, Airspeed Oxfords and De Havilland Dragonfly and Tiger Moth trainers.

Prototype of new Burnelli flying wing is undergoing nearing completion at Montreal factory of Canadian Car & Foundry Co., which holds the British Empire rights to make this aircraft.

De Havilland of Canada recently completed 750th Canadian Mosquito.

Larger aircraft than Lancaster are to be made in Canada, according to Minister C. D. Howe. Later this year, Victory Aircraft, Toronto is to start on larger bomber understood to be in B-29-size category (Editor's note: likely Avro Lincoln. See "Spot Checking," page 208 May AVIATION). An improved Mosquito bomber is also to go into production. Minister Howe further stated that substantial contracts for aircraft components have been received from U. S. Total Canadian production in 1944 is to be 2,201 combat aircraft, according to official announcement.

To C. H. Ney, of Geodetic Service of Canada, has gone Professional Institute Medal Award. Was in pure science field for his investigations in astronomical, magnetic, and meteorological problems of trans-polar aviation. Then Mr. Ney was a pilot with RFC and RAF during World War I.

Agreement with Sweden will allow aircraft of that country to fly over eastern Canada on a route from Sweden via Iceland to New York. Canada has a reciprocal right to fly over Sweden under this agreement.

TCA had a '44 operating revenue of $15,814,647 compared to $5,870,501 in '43. Operating expenses increased to $10,070,807, a jump of $4,695,906. CPA had an operation loss last year of $767,109, reported to be due to unprofitable earnings on certain routes on which rates could not be increased by wartime regulations. The company carried 104,166 passengers in '44, compared with 12,002 in '43.

★ OBITUARY ★

Marshall Headle, former Lockheed chief test pilot. In World War I he was flight instructor for U. S. Army in France, and later flew for Marine Corps. Among numerous planes he tested was P-38 in its first flight early in '38.

Palmer A. Hewlett, Convair's export sales director. During World War I he served as Wash. ington representative for Curtiss Aeroplane & Motor Corp. Later becoming an official of Aviation Mfg. Corp. and Vultee Aircraft.

Cleeson E. Sheeler, shop superintendent of Panam's maintenance department at LaGuardia Field. He joined PAA in 1929 at Brownsville terminal as assistant chief of engine overhaul and co-pilot, later becoming shop superintendent there. In World War I he served as mechanic and pilot with Army Air Corps.

Charles P. Sander, assistant chief engineer of Fairchild's Ranger Aircraft Engine Div. He formerly was associated with General Electric Co., was chief engineer and sales manager for Kinner Airplane & Motor Corp., chief engineer for Menasco Mfg. Co., and consulting engineer for Vega Aircraft.

James H. McKee, executive engineer, Curtiss-Wright Propeller Div. He was noted for his work with hollow steel propeller blade and was pioneer in its development.

Arthur J. Sweet, liaison engineer, CAA's Technical Development Div. He was formerly associated with Westinghouse and had been engaged in independent consulting practice.

LATEST PRODUCTION-MODEL MARINER

This new Martin Mariner PBM 5 patrol bomber—third model, sixth version—is now in production, and it has seen combat action. Featuring redesigned engine cowls, airscoops, and internal changes, it is powered by two P&W R-2800 Double Wasp engines of more than 2,000-hp. each. Craft also uses jet-assisted takeoff calculated to reduce getaway runs from 33 to 60 percent, thus permitting carriage of heavier loads. During recent services tests at Naval Air Station, Patuxent, Md., new PBM 5 flew a 25 hr. 6 min. endurance flight, breaking previous Mariner records by nearly 10 hr. Streamlined bulge just behind pilot's cockpit presumably houses special search equipment.

AMERICA AT WAR

Aviation's Commander No. 41

The air war in Europe came to a victorious close in two steps. First, strategic bombing was stopped having mortally slowed German industrial production, particularly that of aircraft and fuel, and having opened the way for the Normandy invasion by severely crippling enemy communications.

Second, both tactical and strategic air forces of AAF and RAF concentrated their work as a tactical force, finished knocking out the Luftwaffe in a final one-day take of nearly 1,000 planes, hit the enemy everywhere at low levels. The cost in aircraft and crewmen was high, but the over-all saving of life and equipment was a bargain.

Van R.'s Viewpoint

Field Marshal Karl von Rundstedt said, when captured, that Allied air power was the biggest factor in the defeat of Germany. Bombs blew the brains out of German armament when they smashed laboratories and drafting offices of the steel industry at Dusseldorf, contributing at least 50 percent to final collapse of the Nazi war machine, according to British Information Services.

Though air war officials have been disappointed with apparent results of some air attacks on Germany, investigations on the ground now reveal that reports of demolition were conservative. Much credit goes to the enemy's tenacity. Dispersed and underground production was not as extensive as generally supposed.

With V-E Day by the boards, Army Air Forces and RAF in Europe are now moving toward Japan. Gen. H. H. Arnold, AAF chief, recently said every available plane would go to the Pacific. It is estimated AAF now has in combat about 75,000 planes, near 40,000 of the combat types, besides the thousands in process and in the pipelines. It is probable that the U. S. and British air forces which will move against Japan will far more than double those of Army and Navy already there.

Gen. Carl A. Spaatz, commander of U. S. strategic air force in Europe, says a medium sized air contingent will be left in Europe, together with air forces of England and Russia, to cooperate with ground forces in keeping the peace. AAF bombers in peace time Europe probably will see little action and will double as troop and cargo carriers.

Summary and Forecast

As U. S. military aviation moves out of Europe, it leaves about 30,000 enemy planes killed," about 5,000 probables, and over 12,000 damaged. It moves out with the satisfaction of a clean victory, but with a respectful memory of the enormous problems with which it grappled to generate such tremendous power in such a small place, (Britain), also awareness of those elements with which Germany offered formidable opposition—i. e., glider war, jet propulsion, and powered and guided missiles. In future one sees aerial attack with explosives, fire and gas, at long range with accuracy, without risk of a pilot's life.

★ CALLING NAMES ★

Fred L. Meagher was appointed v-p of Jordanoff Aviation Corp

William J. Turnbull became asst director of procurement at Glenn L. Martin.

Herbert P. Ladds, pres. of National Screw & Mfg Co., and director of Aviation Distributors & Manufacturers Assn., is now pres. of Cleveland C. of C.

Gernadine Baker is now active director of public relations and advertising for Southwest Airways

Maj. Leslie A. Bryan has been appointed director of new N. Y. State Bureau of Aviation in the state dept. of commerce. **Charles P. "Chuck" O'Connor** was made pilot for department.

Oliver F. Johnson, previously with OPA, has joined Fairchild Camera & Instrument to do market research and post-war sales and distribution planning

Robert H. Ebbits, Jr., has been appointed N. Y. C. district traffic mgr., traffic and research dept., of Northeast Airlines

Wladimir A. Reichel has joined Kearfott Engineering Co., specialized marine and aviation equipment firm.

John O. Harrower was elected v-p. in charge of sales and engineering for Air Associates

Floyd B. Dean, managing director of F. B. Dean & Co. was elected a director of The Aviadex Corp

C. C. Layman became pres. and gen. mgr. of Aeronautical Products Inc., with **Edward C. Janke** promoted to v-p. in charge of sales. **M. J. Whitfield** has been named exec. v-p. and **Byron Layman**, company treas.

W. Alton Jones, Merritt C. Mapa, and **Wayne Parrish** have been elected to board of directors of Air Power League

Hervey E. Stowers was appointed special asst. to pres. of ACCA for wealers U. S

Ira K. Black is chairman, and **J. W. Rogers, W. B. Meredith, B. J. Eaves, W. J. Maze**, and **S. N. Castle** are members, of newly organized SAE Hawaiian section

Timm Aircraft Corp. appointments **Roy G. Buckley**, exec. v-p., **Gen. P. Mirdy**, v-p.-treas., and **Hyman Smith**, secy

Okla. City Aviation Club elections **Fred Bartholomew**, pres.; **Keith Kahle**, v.-p.; **Mrs. Clayton Johnson**, secy.-treas.

Ira W. Pike has been elected to board of directors of Aircraft Mechanics, Inc.

Convair appointments **James L. Kelley**, San Diego plant div. mgr., will also serve in same position at Tucson plant. **C. E. "Tug" White** became chief of industrial engineering at Tucson plant, replacing **W. R. "Bill" Miller**, transferred to New Orleans as chief industrial engineer. **W. E. Brainard** became chief tool engineer at Vultee Field div. **R. S. Benton** has been named chief of industrial relations dept. at Miami div. **K. A. Day** was made supt. of modification, **R. F. McAnley** was transferred to become supt. of final assembly, and **Hugh L. Winsett** has been promoted to asst. supt. of subassemblies at Fort Worth B-32 plant

Capt. Frank Judd has been appointed to newly created position of general mgr. of NWA western region. **W. R. England**, company's traffic mgr. at Spokane, Wash., has been named to similar post at Detroit. **Oscar Mordell**, traffic representative at Minneapolis, and **Morris Bakken**, St. Paul, also joined Detroit staff. **William H. Forbes, Jr.**, is new acting district traffic mgr. in Chicago

Elmer R. Crane, formerly of WPB, is new head of Grand Rapids, Mich., plant of Leaf Inc. **William J. Perfield**, previously with Air Associates and Howard Aircraft, was made chief engineer, mechanical div.

H. T. Carpenter has been appointed treas. of J. P. Riddle Co., Miami, Fla.

Orr Onnther Mohling, with Allegheny Ludlum Steel Corp., received a cash award and certificate of appreciation from board of directors for contribution in developing high temperature alloys connected with jet turbine aircraft engines.

John J. Haspers has been named Vought Aircraft div. sales mgr., and **William H. McCarthy** becomes company field service mgr.

George Myrick, formerly with CAA, now marketing director for Bendix radio, is new mgr. of division's personal aviation sales. **Charles F. Luscombe** has been made sales engineer for personal plane radios engineering development post has gone to **Vernon Moore**, general supervision of personal plane engineering sales will be handled by **W. L. Webb** and **John W. Hammond**

Grover Loening, WPB consultant, has joined NACA in same capacity

Louis A. Traxel has been appointed personnel director of AA.

Lt. Gen. William S. Knudsen has finished special assignment organizing ATSC and has now resumed duties as War Dept. director of production.

George P. Saunders is director of Western Air Lines' newly created public relations dept

C. R. Starnes was elected v-p of Globe Aircraft Corp

Homer L. Bredenw was elected chairman of board of Missouri Aviation Corp., Kansas City. Others elected to board were **F. C. Kathe**, pres.; **James N. Thompson** and **W. J. Hermann**, vice-presidents; **Fred R. Salinger**, secy.-treas.; **Marion Metchar**, asst. secy.; also **Taylor S. Abernathy, Joseph J. McGee**, and **Paul D. Selby**.

(Continued on page 215)

'COPTER AUTHORITIES CONVENE

Among experts at recent annual forum of American Helicopter Society at Philadelphia were (left to right) R. H. Prewitt, forum technical chairman; J. G. Ray, veteran rotary wing pilot and vice president of Southwest Airways; and C. L. Morris, director of field activities for Bendix Helicopter. Concerned with technical and economic aspects of rotor craft, forum was attended by well-known designers, engineers, operators and pilots.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

This Capitol undoubtedly will be a great world air center. Already, four years after opening of the National Airport, need for another field is in sight. CAA hopes to take over ATC's terminal on National at war's end. There may be experimentation with one terminal for incoming and another for outgoing traffic.

American-Flag foreign air service proposal (chosen instrument) is deemed killed. And now, how will the U. S. keep out of airline subsidy race in the coming struggle for air transport as a factor in air power? To that nobody knows the answer.

Pres. Truman is interested in aviation, knows much more about it than the average official, and will aid its advancement to the utmost. As former chairman of Senate War Investigating Committee, he made probes of the industry and the air forces and indications are that he will support a continuing examination of all that goes on.

Victory over Germany, coming in bits and pieces, brought not enough excitement to outweigh discounting factors—the tragedy of the passing of Pres. Roosevelt, and the continuing struggle against Japan. Officialdom knows that aviation has proved the most potent new weapon in history, but it is still not sure of its measure against surface borne guns and fire. Many still hope Japan can be done in, or nearly so, by air attack.

Surplus Property Board has persuaded Army and Navy to stage a show at National Airport here, demonstrating process of obsolescence in warplanes—preparing Congress and the public for junking thousands of non-convertible models at huge loss.

Old local range system of instrument approach, which reached practical stage as war began, will be used for some years in peacetime, though already obsolescent. Collision warning and altimeter applications of radar will be combined with the ranges. Full radar instrumentation is expected in five or six years. Government will take firm stand for technological freeze period of application and use. Delay would be continuous if engineers were allowed to wait for improvements, which will not end for generations.

The battle for radio frequency channels grows hotter. Railroads and busses will get a fraction of what they ask. Local and federal police demands will increase. Public communications offering to cut rates on wireless phone, will take a slice. There will be many wanting walkie-talkies. Eventual needs of private flying will be enormous. Meantime, engineers are extending the channels higher and splitting them finer, and somehow, there will be a meeting of the various demands.

V-E Brings Cutback, Terminatinn, Conversinn, And Surplus Problems; Plane Pieture Gaged

. . . Navy osks 19,140 planes, 5,090 andar '45 ardar . . . 6,412 craft mads in April . . . Chamber advisas changa on minimum parfarmance . . . Plan offered for salvaging surplus-craft aluminum . . . Set up ATSC price sectina . . . Yange new NACA policies.

End of the war in Europe brought the U. S. aircraft manufacturing industry face to face with large cutback orders, unprecedented problems in contract terminations disposal of surplus plant and equipment, and conversion to peacetime production

Paralleling these difficulties is the assured requirement of maximum production of some AAF airplane types, and near maximum output of most Navy types, for continued war against Japan.

Though it will be hard to deal with shutdowns and urgent orders at the same time on the other hand, extended production for the Pacific war will soften the shock of stoppages

WPB had its outback program ready as hostilities wound up in Europe but at this writing full details were not ready for release. However, the taper-off will be subject to drastic changes from time to time, depending on strategy, which depends upon what line of defenses the enemy may take

Meantime, the current curtailment picture can be outlined Production of B-24's is being reined-in, notably at Willow Run and undoubtedly toward a final closeout B-17's are tapering off; it is not certain whether delivery of them will continue through the war. B-26 is completed Schedules call for level production of B-25's, but here there could be a revision, depending on the aircraft's usefulness in the fast-changing war The A-26 fighter-bomber looks like a good bet for the duration

P-38's are being cut sharply after an inestimable contribution to the air war P-51's and P-47's are coming out in revised design Continuation of conventional fighters depends upon combat success of the Lockheed P-80 and other jet-powered models to come Evacuation of U. S forces in Europe, plus demands of the long supply lines in the Pacific will call for all the transport equipment that can be built

Production of engines is being cut even more than airframes, because of spares on hand also because of jets supplanting conventional power Some of the engine capacity converts to jet and turbine power

B-29's, jet fighters, and transport will be high priority from here out

Navy Asks 19,140 Planes, 5 090 Under '45 Order

The Navy's war in the Pacific goes on unchanged except that the defeat of Germany will mean it will now be backed up by more power from the Army and from the British. The Navy has asked Congress for $2 9 billion to procure 19,140 airplanes between July 1, 1946, and June 30, 1947, thus planning its needs one year ahead of normal procedure The 1946 program calls for 5,090 planes less than the 1945 program, which specified 24.706 Contract authorization, rather than cash appropriations, are called for, thus simplifying cancellation in case the aircraft are not needed

House Appropriations Committee already has the request Navy testimony indicated 10,560 fighters are being called for, along with 2,400 dive bombers, 4 500 torpedo bombers, and 1 680 patrol bombers, marine and land types The Navy has about 36 000 planes and is taking deliveries at the rate of about 2.000 per month

6,412 Craft Made in April

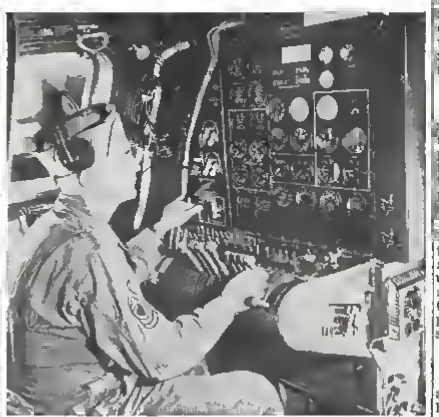
Production of all critical airplanes was on, or in excess of, schedule in April, but unit output dropped from the 7 053 in March to 6,412, which was still 64 units abeve schedule April was the last of the two-war production months. The rate is expected to drop back from now on—to 5 000 per month or less This lower rate might not be reached till the year end Even if the Jap airforce were considered liquidated Army and Navy still could use large air forces for bombing and strafing and for transportation

Chamber Advises Changa On Minimum Performance

A basically new approach to design of personal airplanes and to the problem of private pilot safety has been proposed by the U S aircraft industry through the Aero Chamber

The Chamber suggests that existing minimum performance requirements, such as takeoff distance, rate of climb, etc, be eliminated and that accurate data on each type a flight characteristics be supplied to pilots by the Government and by the manufacturer

ACCA s belief is that liberalization of present rigid stipulations would accelerate improvement of design and increase the utility of postwar planes There is already much debate as to whether non-professional pilots should be trusted with aircraft that require any more judgment than they do now



SUPERFORT S FLIGHT ENGINEER STATION

This is first photo to be released of flight engineer's station on Seeing 9 29 Superfortress Noteworthy for such a large plane is compactness of control panel System distinguishes 9 29 from previous designs in that flight engineer setup relieves both commander and pilot of majority of engine control duties and basic mechanical-system operations thus flyers may concentrate on command of ship and on combat strategy Located on starboard side of craft directly aft of pilot, flight engineer faces toward tail.

Plan Offered for Salvaging Surplus-Craft Aluminum

As the nation's leaders debated disposal of mountains of useless war machines and as the Surplus Property Board authorized Army and Navy to junk all tactical airplanes clearly useless in civilian hands, Aluminum Co of America announced a means of converting scrap aluminum into new aluminum equivalent to the original product

Heretofore disassembly of airplanes so that steel, aluminum, copper, lead, rubber and the like could be separated—cost more than the junk value Alcoa says the airplanes are put into a bath of caustic soda which dissolves the aluminum while not attacking other metals or the alloying elements of the aluminum There is a growing demand that maximum saving of war metals be affected, also that metals be returned from foreign countries, where if left they might eventually be used in some new unwanted hostilities

Set Up ATSC Price Section

Air Technical Service Command at Wright Field has established a sub-section of the production section to administer price analysis and statutory renegotiation in aircraft procurement The price section is headed by Lt Col A P Smith of New Orleans Purpose of the new office is to keep prices as near as possible to the levels common under normal competition In addition to watching prices, the office will try to recapture profits gained through excessive prices.

Range New NACA Policies

A suggested future policy and program for the NACA has been drafted by the new Technological Development Committee of the Aero Chamber A copy of the draft now being revised by committeemen and ACCA officials presumably has gone to Congress It is understood the Chamber has criticized some aspects of NACA's activities Final draft of plan will be made public

The Committee also discussed, at recent meetings ways and means of keeping alive public interest in technological aero research in peacetime. This is regarded as a very difficult problem, because the motivation of war will be missing.

★ ASSEMBLY LINES ★

Convair is transferring production of TBY-2 Seawolf and P-38 Lightning parts from Miami div to company's Nashville plant. Tucson plant is working under heaviest schedule yet assigned, with four types of planes to be modified. Among craft are B-24 Liberators, BY-3 transports and P-38 Lightnings.

Martin has opened classes to train maintenance and operational men in handling Mars cargo planes now coming off ways.

Boeing of Wichita is now turning out B-29 Superforts fully equipped for combat with all modifications completed at plant before delivery.

Ryan's orders for new Navy fighter now exceed $100,000,000 and a contract has been received for $800,000 worth of a special type exhaust manifold for a new Merlin combat plane.

Vought reveals that Fairchild Aircraft of Canada will turn out fuselage stabilizers, elevators and wing flaps for Corsair fighter.

WPB has formed Aerial Delivery Parachute Industry Advisory Committee to expedite AAF's expanded parachute program.

Ford turned out 80,000th P & W 18-cyl engine. Company started production of engines in Aug 1941.

Eastern Aircraft stopped production for one week to complete details for production of a new type plane.

Detroit Gear Div. of Borg Warner states that production of helicopter transmissions and other airplane gearing will be continued by company after war.

North American's Kansas City plant produced 6,000th B-25. Facilities are being converted to handle production of Lockheed P-80 jet fighter.

Douglas is pushing production of big C-74 transports for AAF with first unit expected to be completed this summer. Craft is military version of company's DC-7.

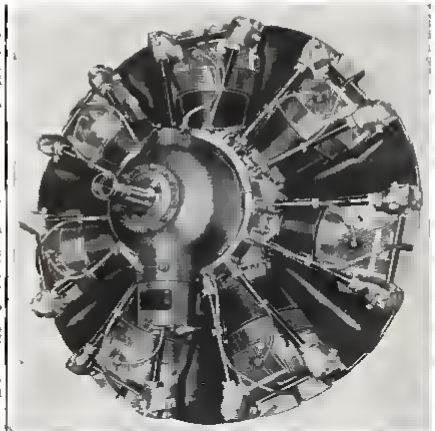
Luscombe's production of sub assemblies for first quarter of this year is double that of same period last year.

AC Spark Plug delivered last of Mark XIV bomb sights for KAF. More than 23,000 sights have been built by company.

Nash Kelvinator received 20 percent cut-back in propeller production. Company delivered 180,000th prop in Feb.

Malabar Machine Co., Los Angeles received $550,000 contract from U. S. Navy for hydraulic aviation jacks.

Wright Aero Co.'s Wood Ridge plant received enough advance war orders for R-20 engines to keep plant in full production for next 18 months. Plant recently reached peak production



WRIGHT ENGINE FOR FEEDERLINERS

Here is an artist's representation of Wright Aero's newly designed 700 hp Cyclone 7. Developed to employ either high or low octane fuel, new plant is proposed especially for use by short-haul feederliner-type transports or military trainers. Design features interchangeability of many parts with those of more powerful Cyclones now in service. Installed in a Curtiss CW22B Falcon, a prototype of this engine has been flown cross country for demonstrations to operators and airplane manufacturers.

two months ahead of schedule and has thus far turned out more than 8,000 Cyclone-18 engines. C-W's Buffalo plant has modified 2,000th plane. Propeller div's Clifton plant and part of Caldwell plant were closed for re-tooling after cutbacks on P-38 propeller blades.

★ KROW-HOWS ★

Walk-around oxygen units have been developed by Ballard Aircraft Arthurdale, W. Va., to permit crewmen to breath while escaping from submerged aircraft.

Special water-cooled, shock-proof X-ray tube, 4½ in. dia., has been produced by North American Philips Co. for examining materials in confined spaces.

Gyro shot peening connecting rods when machining instead of polishing them. Sidebaker Corp. states it both increased strength and cut down production cost.

Bearing service station installed at Martin's for reclaiming ball bearings is stated to have saved $150,000 in first year of operation.

Flash welding of parts which formerly were made by forging processes is asserted by Curtiss-Wright to have affected large savings at company's Columbus, Ohio, plant. Company also announces development of automatic riveting machine able to drive 3,000 rivets per hour.

Engine performance calculator to give flight engineers instant results, has been invented by H. B. Riggs of Convair. Calculator is plastic disk-form device.

Lighter engine mount, newly devised by Goodyear, is stated to permit useful load increase of more than 100 lb. per plane.

Electrical harness tester using pinball-machine principle is reported by Boeing to give speedier and more accurate results than older methods.

A Covering of metalare-proof transparent cellulose film is now used over emergency equipment on PAA Clippers both for better projection and to enable contents to be checked without opening, says Sylvania Industrial Corp., maker.

High hydrogen-carbon ratio jet motor fuel developed by Richfield is stated to give greatly increased power output and heat efficiency.

★ FOR THE RECORD ★

U. S. Plywood Corp has moved executive offices to Woolwood Building, 55 West 44th St., N. Y. C.

Fairchild Aircraft Div. will construct a new 60,000 sq. ft. hangar in addition to present plant facilities at Hagerstown, Md. Plans also call for five acres of new apron paving.

Atlantic Western Airlines, Virginia concern with hq. in Danville, has leased office space at Woodrum Field. New Company plans two flights daily between Danville, Lynchburg, Roanoke and Richmond.

Luscombe Airplane Corp. has purchased 500 acres northeast of Dallas, Tex., and will erect an aircraft factory and develop a new airport in order to expand production facilities.

The Austin Co., engineering and building firm, has established Austin Aviation div., with hq. in Cleveland, headed by W. K. Enestram, company v-p.

Stout Research Div., of Convair, will be moved from Dearborn to Nashville, Tenn., in order to utilize company's surplus facilities.

Pacific Airmotive Corp. is new name of Airplane Mfg. & Supply Corp.

Aviation Research Associates transferred offices to Academy of Aeronautics building, La-Guardia Field, N. Y. C.

Cension is new trade name for Convair plastic formerly known as Conolite.

Western Finance Co., 915 Euclid Ave., Cleveland, Ohio, has been formed to develop plan for financing student pilot training and pilot's solo time in school-owned planes. Company also finances new and used plane sales.

NACA has received WPB approval for construction of an 8,500 sq. ft. addition to aircraft research laboratory at Cleveland. Costing an estimated $100,000, building will be an additional fuel injection laboratory.

Surface Combustion Corp., with hq. in Toledo, Ohio, has consolidated all N. Y. C. offices at Transportation Building, 220 Broadway, N. Y. C.

Flotrol systems, Inc., is new name of Aqua Petroleum Systems, Inc. Concern makes hydraulic fueline systems and water separators.

★ CALLING NAMES ★

(*Continued from page 211*)

Malcolm S. Clark was elected chairman of board of directors of Jacobs Aircraft Engine Co.

Alan F. King was appointed to office of Director of economic research of Curtiss-Wright Aircraft Co. **Arnold Johnson** was made plant mgr. of Weber Showcase & Fixture Co., and will continue his duties as mgr. of company's aircraft div.

Maurice L. Sroder has joined UAL in N. Y. C. as asst. mgr. of transit traffic. **L. T. Long** has been transferred to Cheyenne to be in charge of company's new engineering development section, with **R. L. McErlen** and **D. W. Taylor** as assistants.

Kenneth G. Loeffler has been appointed Braniff Airways station master in Tulsa.

Vincent McComb is new NAL traffic mgr. for N. Y. C., and **Helen Berg** became city traffic mgr. at Miami.

Western Air Lines elections: **William A. Coulter**, again pres., **L. H. Dwerlkotte**, exec. v-p., **Charles N. James**, v-p. in charge of operations, **Thomas Wolfe**, v-p. in charge of traffic, and **Paul E. Sullivan**, v-p. and sec.

George W. Mason and **David L. Frawley** were elected to PCA board of directors, with **C. Snell Manes** re-elected pres., and **Raymond G. Lechiel**, elected vice-pres. and continuing as treas.

J. H. Rose has been appointed asst. sales mgr. of Automotive & Aircraft div. of American Chain & Cable Co.

E. Griggs La Touche has been appointed to administer Griggs Clarifier Co. a aviation div. field engineering staff.

T. F. Ryan III has been elected a director of Mid-Continent Airlines.

Flash Initial Go-Ahead for New Airliners; Three-Man Committee Studies Requirements

. . . CAB asks equitable state-tax formula . . . See compromise resolving mail-pay controversy . . . "Chosen instrument" bill deemed beaten . . . Act revision comes up . . . Refer off-airway problem to Attorney General . . . AEA signs for landplanes.

After three years of zero production of airplanes for the civilian transport industry, WPB finally removed restrictions so a start could be made on the 300 planes wanted by the airlines this year and next, "provided there is no interference with present or subsequent military aircraft production schedules and development commitments."

Army and Navy both had authorized Chairman J A Krug of WPB to give the manufacturers a rating of AA-1 on airline planes, which will provide tools and materials Production must not interfere with war requirements, but manpower released from cutback orders should help

One difficulty will be in components produced by the manufacturers who are still sewed up tight with the war But all transportation is now rated as a war essential and it is expected components necessary for production of airline equipment can be released Another problem was anticipated in getting quick release of tools and equipment by the defense plant corporation

Airline equipment schedules are handled by a new committee of three men, one each from Army, Navy, and WPB Henry P Nelson director of the Aircraft Division of WPB and member of APB, says the three-man committee, whose members were not named, is carefully studying ways and means of meeting the airlines requirements. Nelson stated total airlines requests for about 300 planes carries through the year 1946 The airlines believe they can provide ground and flight crews for whatever additional planes they can get.

Meanwhile allocation of war surplus DC-3 types Lockheeds, and smaller planes to the airlines and other users continues a few at a time Operators are extending their plans for conversion especially with "Douglas approved' modification centers

CAB Asks Equitable State-Tax Formula

In accordance with an order from Congress following Supreme Court decision against Northwest Airlines in the multiple state tax case CAB has recommended to Congress that it enact a statute requiring equitable apportionment of taxable property among the states theough which airlines pass.

Because cases would vary widely, the Board recommends thet an existing federal agency interpret and administer the formula, with a committe of tax experts from the states concerned

Criticizing taxation of aviation fuel by states the Board recommended exclusive federal taxation of aviation fuel and exclusive auto fuel taxation by states The report to Congress suggested that multiple taxation is broader than aviation and that general fiscal relations between states and the federal government should be investigated.

See Compromise Resolving Mail-Pay Controversy

United, TWA, and Eastern have joined American Airlines in opposing CAB's proposed mail-pay cut from 60 to 32c per ton-mile TWA says in its brief that airlines should be permitted to build up reserves in good times for bad times Company says its average net income for 11 yr has been $201,547, or 2 92 percent, on the average investment, and it challenges CAB's estimate of its high passenger load factor income in the future

United also replies thet the Board is basing its calculations on temporary load factors and earnings And Eastern emphasizes advantages that would accrue to small lines if the 50 percent cut is put on the big lines

CAB's proposed reduction is a bargaining stand, and the final decision will be a compromise The out might be very slight if airlines convince the Board thet passenger fare reductions would serve public interest just as well

"Chosen Instrument" Bill Deemed Beaten

Hearings on PAA's proposed All-American Flag Line foreign service bill, presented by Sen Pat McCarran, have been completed, and informed opinion is that the "chosen instrument"measure is beaten. It seemed doubtful at this writing whether a majority of the Senate Commerce Committee could be mustered to report the measure to the floor Defeat in a Senate vote, in case it is brought up, seemed certain and observers doubted whether the House would ever consider tbe bill

It Is thought likely Pres Truman will continue Mr Roosevelt's policy on foreign-service aviation and veto any 'chosen instrument" legislation. Alexander E Royce, chairman of the 17 Airlines Committee, told the Senate Committee that the airlines would participate in neither an American chosen instrument nor an international cartel such as Britain is fostering.

KELLETT COMES UP WITH COPTER

Here is first photo of Kellett's XR-8 helicopter for AAF. Rotor blades on two place craft are arranged in two sets of three blades each and overlap as they contra-rotate. Counter rotation obviates necessity for tail rotor Powered by a 245 hp- XO-405 engine, craft has a 40 ft. rotor span- Length of fuselage is 22 ft 7 in height is 11 ft, and blade loading is 35.2 lb/sq- ft Gross weight is 2 975 lb , while weight empty is 2 320 lb Controls are stated to be of conventional helicopter type, including stick-pitch control lever, and rudder pedals.

Act Revision Comes Up

Due to begin about now are hearings on Sen Pat McCarran's omnibus bill to revise the Civil Aeronautics Act The bill calls for reinstating the Civil Aeronautics Authority (CAB and CAA) independent of the Commerce Department, and it asks creation of an Air Safety Board, independent of the Authority, as it was before the President reorganized CAA several years ago. Also dealing with several other matters, this bill is similar in many respects to the Lea omnibus bill, revising the Act on which hearings had not been scheduled at press time

Refer Off-Airway Problem To Attorney General

A recent order by the Administrator requires airlines operators to justify off-airway operations, and advises that such operations where time saving is small, soon must be discontinued The order was issued when CAA's general counsel ruled that the law requires the Administrator to designate an airway over any route authorized for scheduled operations

Counsel for the Board has taken exception to CAA's finding and both the Board and CAA have prepared briefs for tbe U S Attorney General who is requested to resolve the difference

The airlines have been flying off-airway for years, in fact airways were not officially designated until recent years. Airlines went to fly off-airways to save miles and to by-pass traffic concentrations caused by the war. Army does not favor more airways which complicate its traffic problems.

Accident Poses Questions

Crash of a Page Airways plane at Washington National Airport killing six persons and injuring five others, brought renewed interest in the problem, encountered in some cases of distinguishing between the charter and contract and public carrier operations There also arose questions regarding the matter of operating certificates from CAA. The Board is investigating the accident and its findings will tend to clarify those and other questions, thus contributing data for study of the proposed regulation of non-scheduled air transport

AEA Signs for Landplanes

American Export Airlines, which began operations with flying boats has announced signing a purchase contract for a fleet of 108-125 passenger landplanes, designated as AE Model 7. Craft is described as having non-stop range of 4,000 mi at cruising speeds in excess of 296 mph.

Company has a good record on the Sikorsky planes Some observers say it was the influences of American Airlines which has applied to CAB for permission to purchase Export, that caused the change of policy

Fast Transcontinent Runs Planned by United

United Air Lines expects to offer coast-to-coast service with two stops in 10 hr 14 min. and with one stop in 8 hr 24 min with postwar four-engined airplanes according to Pres W A Patterson.

Speaking at the Chicago Forum on Aviation, Mr Patterson said helicopter in years to come may compete with 2c-per-mile rates on buses in short haul He again urged regulation of non-scheduled services If all inter-city first-class mail between points 400 mi. apart were flown, he said, total mail volume would be six times prewar volume If parcel post is established, volume would increase another five times.

★ CROSS COUNTRY ★

AA started its new N Y-Los Angeles Ironsconfiental service via Tulsa and Oklahoma City, also resumed daily passenger Chicago-Peoria flights.

Commercial flying a yearly gasoline bill will reach more than $70,000,000 within a decade according to G K. Brower, of AA

UAL has begun experimental survey to formulate rates on air shipped perishables Test consignment of 6,487 lb. of asparagus was flown from California to Cleveland, with plane interior kept at 40-55 deg F temperature asparagus being trimmed before shipping Previous store sales showed 71 percent of shipment sold first day, rest went next day Company has inaugurated new direct service between Cleveland and Boston and Hartford also between Salt Lake City and Spokane, Wash

L. Welch Pogue, CAB chairman says officially that North Atlantic routes will be the first runs awarded for international operations.

Western Air Lines celebrated 18th anniversary In past year company carried 150,000 passengers over 4,100 mi of routes in addition to operations to Alaska and Aleutians for ATC

Northeast Airlines has started N Y.-Boston service, flying nine round-trips daily.

Conn. General Life Insurance Co has liberalized accident insurance for air passengers under which aviation coverage in company's regular accident policies will include all normal passenger hazards without additional charge Policy covers passengers on private and non-scheduled commercial flights made in North America in licensed aircraft of U S registry operated by licensed pilots.

Flight operations TWA flew 50,738,056 revenue passenger miles in first quarter of 45, a 50 percent increase over same period last year Carried were 9,251,500 lb of airmail and the express volume was up 61.8 per-cent. UAL now flies 100,000 mi daily with fleet averaging almost 12 hr. daily per plane It is stated there are nevereless than 25 Mallainers and Constellners in air Peak is 96 planes.

Feederlines: Dayton & Western Airlines, Dayton Ohio, has filed an application with CAB for permission to operate airplanes and helicopters over routes in Ohio, Indiana, and Michigan with Toledo as system's hub

Zimmerly Air Transport has purchased a Lockheed Lodestar for operation on routes in Idaho

Robertson Aviation is using Fairchild 24's on one flight daily service between Ithaca and N Y C Yankee Skylines inaugurated daily air freight service between Burlington, Rutland, Buffalo, Detroit and return Nevada Pacific Airlines began passenger service between Reno and Las Vegas, using Fairchild 45's

PAA airport-clerks, dispatchers, porters, and other operations personnel in Latin American divisions are to be trained to take weather observations and make weather reports used by company's forecasting stations and flight officers Company's air cargo service is handling more than $1,500,000 monthly in fur shipments, with the biggest market for goods in Latin America Recently PAA made an up-to-50 percent reduction in rates for shipping raw furs and skins Panagra had certificate amended to permit service between Lima and Iquitos, Peru, via Juanjui, Peru

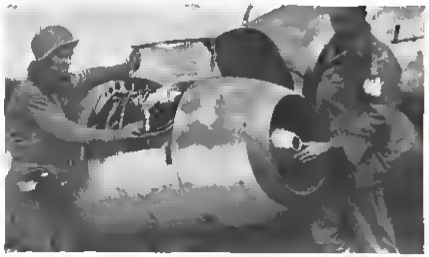
Essair, Inc., received temporary certificate to operate between Houston and Amarillo via Austin, San Angelo Abilene and Lubbock, Tex.

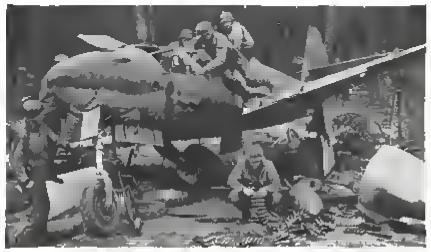
Northwest Airlines has organized new eastern region setup, bounded by Winnipeg, Canada Grand Forks and Fargo N D Minneapolis-St. Paul, Milwaukee, Chicago, Detroit, and N Y C Company is beginning familiarization flights into Detroit and N Y C prior to inaugurating service from Pacific Northwest into Eastern seaboard

Continental Air Lines has created an entirely new department, named flight service department, responsible for central reservations control passenger service, station service hostess service, and food service Functions were formerly handled by traffic and operations departments.

All American Aviation celebrated sixth anniversary of pickup air service. Company has grown from two experimental routes 1,040 mi long serving 16 communities to a system of five routes extending 1,668 mi, reaching 118 communities and requiring 5,084 mi of flying each day In past year 70,488 pickups and deliveries were made with mail amounting to 954,800 lb, and air express 181,000 lb. Air mail revenue totaled $1,015,000

Gen Brehon Somervell reveals that ATC will flew 12 five ton gas powered locomotives from Miami to Burma to help counter a British supply problem there Shipment was by 27 planes.





YANKS CORRAL NAZI SQUIRT

A Messerschmitt 262 twin-jet fighter bomber, captured on an airfield over-run by Gen Patch's 7th Army is examined by U. S armored troops Top photo shows nose portion of starboard jet unit, with inspection panel open revealing interior. Photo above shows some of craft's salient features, including retractable tricycle landing gear. When this view was snapped jet units had been dismantled but some of connections may be seen dangling from beneath left wing just outboard of landing gear strut. Open panel in front of craft's cockpit disclosed fair fixed cannon. Wing span is about 41 ft., length about 35 ft. Cockpit is fitted with a seat ejector device to throw pilot clear of craft in event of emergency. (International News photos)

★ INTERNATIONAL BRIEFS ★

England

Recent reports state the Lancastrian civil version of Lancaster bomber has a high speed of 310 mph. and a 4,000-mi range at 220 mph. with a 2-ton payload.

Following America's example of NACA, Sir Stafford Cripps has announced that a research station will be built in United Kingdom for investigation of problems on new aircraft.

One of Lancaster bombers has chalked up 137 missions, flying 900 hr. and using 736,750 gal. of fuel or 240 gal. per hour. This bomber is still on active duty, continuing long service since first operational flight in May 1943.

Discussions in Parliament disclosed that Tudor II is designed to carry twice as many passengers as Tudor I that six Brabazons are being built, together with prototypes of 8- and 14-seat feederliners and that aircraft for postwar international service are expected to come off British production lines within three months.

Plans for London airport, submitted in recent Aeroplane competition are reported to have brought out unusual number of features of interest to designers.

De Havilland is building a prototype of DH 104 Dove feederliner for eight passengers powered with two Gipsy queen engines. Reversible pitch propellers will be employed to shorten landing runs.

Russia

News releases from Moscow tell of Russia's new reconnaissance planes capable of continuous patrols of more than 60 hr. Some of these craft have been flown in North Polar regions.

France

A new company, known as Aeropia (Compagnie Europienne de Navigation Aerienne) has been formed in France. It plans trunk routes in Europe following establishment of wholly-owned subsidiaries in some 24 countries.

Fifty trans Atlantic flying boats are to be built in France at a cost of $250 million, it is said. For operation between Toulouse and New York, these planes are expected to weigh 150,000 lb. and carry up to 100 passengers.

Test flights were recently made with Latecoere 631, six-engined flying boat. This craft which was hidden piecemeal by the French patriots when Germans occupied all of France.

French Air Force now has some 100,000 men, as against 80,000 just before war. Much of training and equipment has been supplied by U. S.

Australia

Trans-Indian Ocean service of Qantas is now being operated on a three-times weekly schedule. Airline has set up a new training school to provide crews with necessary training for operation.

Australian National Airways has announced its postwar plans, which include, in addition to greatly expanded internal airlines, following international routes: Australia-England, Australia-America, Australia-Vladivostok via China and Japan, Australia-Netherlands Indies, and Australia-Philippines.

Ansett Airways reports opening of daily schedule service between Melbourne and Canberra and between Melbourne and Adelaide. New equipment will make greater frequency of service possible.

Germany

Tools and equipment for construction of Junkers 88 craft are said to have been flown to Japan prior to Germany's defeat. Several of these planes have already been seen in Far East, where they have code name Janice.

Additions to list of German swan-song planes are: He-177 with four engines in four nacelles instead of two, six-engined Ju-890 said to have been readied for Hitler's escape and 60-ton 6-engined FW-300 bomber. In last gasp, Luftwaffe used outmoded Stukas to attempt to stem Allied tide. Reports even have it that Nazis put World War I war planes into the air.

Sweden

Representatives of both Swedish Intercontinental Air Lines and ABA recently sat in on conferences at Douglas concerning equipment on DC-4 and DC-6 commercial planes. Both SILA and ABA are known to have ordered a number of DC-6's.

Opening of Swedish courier-plane service to U. S. is expected before mid-summer.

Argentina

Government announces that a $30 million airport will be constructed just outside Buenos Aires.

Movements of foreign air carriers over Argentina have been limited to certain corridors and zones. Such carriers, it is stated, will not be allowed to "invade sphere of action reserved for Argentinian airlines."

From Pedro J. Noiseux comes report that Aero Club of Argentina is opening chain of connecting service stations which will have landing strips and be equipped to service private aircraft.

WORLDATA . . . . . By "VISTA"

With V-E Day Past, the path is now being cleared for rebirth of various European airlines. First steps toward commercial operations have already been taken by earlier-liberated countries, and the recent reorganization meeting of the International Air Traffic Assn. at Havana further clarified details. IATA plans Paris meeting July 30 and a general meeting Oct. 16 in Montreal.

Quite a controversy arose in England concerning the White Paper outlining the three-company organization of United Kingdom postwar civil airlines. (See Worldata, May **Aviation**.) Smaller airlines and other companies with postwar air plans claimed they were not consulted regarding the formula, hence a likelihood of friction was seen. Under the criticism and pressure, the Government backed away, now classing the Paper as a suggestion rather than a final blueprint of Britain's postwar airline setup.

Called for by this White Paper were three outfits, with the existing BOAC playing a part in each. Company A (BOAC and large international steamship operators) was slated to serve the British Commonwealth, U. S., and Far East. Company B (railways, travel agencies, smaller steamship lines and BOAC) was to run lines inside the United Kingdom and to European destinations. And Company C (steamship lines now operating to South America and BOAC) was to operate to Spain, Portugal, West Africa, and all of South America. The latter company was expected to be a modification of BLAA (British Latin American Airlines), which recently announced purchase of a number of Avro Tudors.

Among those released from the German concentration camps was Albert Plesman, who had been managing director of KLM Royal Dutch Airlines. Mr. Plesman had been in custody of the Germans since 1941 when, according to available information, his refusal to cooperate with the invaders led to his arrest. Resuming his managing directorship of KLM, Mr. Plesman has since been elected to the executive committee of the new IATA.

TACA Airways has completed arrangements for new financing totaling $1,410,000 in form of privately-issued short term notes convertible into common stock. Notes carry 4 percent interest and were purchased by present stockholders, including TWA. It is understood notes are convertible into common at $8 a share.

Boeing Airplane Co. reports 1944 sales totaled $608,082,413 against $493,186,161 in 1943, while net profit was $5,257,522 or $4.86 a share against $4,462,870 or $4.14 a share in 1943. Chairman C. L. Egtvedt told stockholders that postwar activities of company should be principally in aircraft field. He added that discussions had been held with airlines regarding their purchase of Boeing transports but that no commitments had been made.

Dividends: Grumman Aircraft paid a $1.50 dividend on May 24. Previous payments were 50c. last November and $1 in May, 1944. . . Boeing paid $1 in April. A similar payment was made in April and November of 1944.

Fairchild Engine & Airplane Corp. reports 1944 sales of $93,212,983 compared with $102,450,364 in 1943, a decline of 8 percent which Pres. J. Carlton Ward, Jr., attributed to large contract terminations and production shifts. Net profits were $1,173,123 or $1.12 a share compared with $1,827,211 or $1.75 a share in 1942.

Unfilled Orders: Ryan Aeronautical has $116,000,000, and Fairchild Engine & Airplane, $108,000,000. Republic Aviation is reported to have $8,000,000 in private amphibian plane orders.

Rendix Aviation Corp. reports 1944 sales of $869,662,826 compared with $822,510,234 in 1943. Unfilled orders on Sept. 30, 1944 were $662,838,569 against $1,016,901 a year earlier. Net profits were $15,290,095 or $7.22 a share, against $14,722,704 or $6.95 a share in 1943. Physical volume of 1944 deliveries were much higher than dollar sales indicated, due to price reductions.

Jacobs Aircraft Engine Co. reports 1944 net earnings of $1,047,765 or $1.62 a share against 1943 net earnings of $1,070,518 or $1.73 a share. Sales were $52,194,622 compared with $61,084,495 in 1943.

Stock Offerings. Thompson Products plans to offer 60,000 shares of new preferred stock priced between $104 and $107 a share with proceeds to be used for refunding 45,000 shares of present preferred stockholders. This represents around one-third of company's capital stock. . . Laister Kauffman Aircraft Corp. has filed an SEC statement for 17,702 shares of preferred stock, 262,314 shares of Class A common stock, 250,000 shares of Class B common and 260,136 shares of Class C common stock. . . Solar Aircraft is offering 10,000 shares of preferred stock at $15.62 a share.

ADDING IT UP.....By RAY HOADLEY

Reconversion. Says Glenn L. Martin: To make possible a smoother reconversion for the aircraft industry when Japan follows Germany into defeat, permission should be granted now by government agencies to plane manufacturers to proceed with postwar engineering and design. As Mr. Martin points out, the aviation industry is assuming a large part of the war production responsibilities of the automobile and other durable civilian goods industries.

Contract Transfers. It is figured effect of contract transfers will be to accentuate the eventual shock of reconversion in the aircraft industry, unless it is permitted to get started on engineering and development work. That would speed up obsolescence of the present types of civilian planes and thus expand the civilian market as soon as possible after V-J Day.

Terminations. Contract terminations probably will average between $2,000,000,000 and $3,000,000,000 a month in coming months, as compared with $1,200,000,000 monthly since passage of the Contract Settlement Act. Fortunately the settlement backlog has declined in the last six months—from a peak of $14,300,000,000 to $9,500,000,000 or about seven months work at the current settlement rate.

Quicker Settlements. With termination orders now due to go out in really big volume, the rate of settlements will have to be speeded up. One way the aircraft industry can help will be to file claims more promptly than in the past. And a way that the government could speed things up decidedly would be to provide more scrap consultants. Experience shows that a large part of termination inventories have only scrap value and should be cleared from the plants as soon as possible. On Apr. 30 there were only 23 such consultants.

Canceled Commitments. Up to Apr. 30, commitments canceled by contract terminations totaled $27,500,000,000, of which $15,000,000,000 had been settled. It is necessary to distinguish between the large amount of canceled commitments and the small amount paid by the government to settle the resulting claims. Payments to contractors to settle almost $15,000,000,000 of canceled fixed-contract claims totaled only $600,000,000. More than 114,000—87 percent of the 132,000 fixed-price prime contracts settled through Mar. 31—were closed without claim.

Interim Financing. Partial payments can now be obtained fairly quickly by prime contractors and the first-tier subcontractors. However, government termination officials themselves admit that mechanisms for partial payment to lower-tier contractors have been cumbersome. But under a new plan, in which pools of funds to be used on a revolving basis for partial and final payments to subcontractors are placed in the hands of prime contractors, it is hoped that partial payments will be available to many more lower-tier subcontractors.

Tax Relief. It would be a great help to aircraft companies if Congress decides to allow companies which hold excess profits tax postwar government bonds to cash a portion of these securities to meet reconversion costs. The aircraft industry holds more than $50,000,000 of such bonds today. Another change along this line that may be made would be to permit companies to estimate their 1944 earnings, calculate the tax refund they would be entitled to, and then deduct the amount of the refund from current payments now being made on 1944 income. In that way a company would collect now a refund it might not otherwise get for two or more years.

Rendix Aviation had sales of $383,000,000 in six months ended Mar. 31 against $475,000,000 in same period a year ago, Pres. Ernest R. Breech told stockholders at annual meeting.

Thompson Products, reports first quarter earnings of $722,427 equal to $1.34 a share against net of $798,006 or $2.47 a share in like 1944 period. Sales were $32,787,495 against $35,769,983 in Mar. 1944 quarter. Thompson Aircraft Products accounted for $12,848,000 of first quarter sales compared with $21,359,000 a year ago.

Fairchild Camera & Instrument Corp. estimates 1944 sales at $42,000,000 compared with sales of 46,780,000 in 1943. Pres. James S. Ogsbury postponed annual meeting due to delay in preparing annual financial statement.

Sperry Corp.'s 1944 net income did not differ substantially from that of 1943, according to Pres. Thomas A. Morgan, who has postponed annual meeting until after completion of annual report for last year. Shipments in year 1944 were approximately $425,000,000 compared with $460,006,689 in 1943.

Aviation Corp. reports sales of $9,814,016 for quarter ended Feb. 28 against sales of $17,677,809 for like 1944 period. Net profits were $1,011,029 equal to 17c a share against net profit of $1,460,863 or 25c. a share a year ago.

Solar Aircraft has a backlog of unfilled orders of around $38,000,000. Sales in year ended Apr. 30 were about $28,000,000. Solar recently completed a new V-loan agreement with bankers involving $12,500,000 to meet working capital requirements.

Aircraft Radio Corp. will offer 100,000 shares of common stock for account of stockholders to pay off a $900,000 bank loan.

ROBERT J. WOODS became special technical advisor to pres. of Bell Aircraft and has been given a new assignment related to company's future aircraft development and production. He had been serving as chief design engineer at Niagara Frontier div. He will also direct corporate product planning group.

JOHN E. P. MORGAN, chairman of ACCA's management committee, has now been named executive director of Chamber, and accordingly he will supervise staff activities. He came to ACCA in Jan. 1945 as manager of PAC. His prior association was as Washington representative of Piper Aeronca and Taylorcraft. A veteran of World War I, he served as a Navy lieutenant on convoy duty following his graduation from Harvard in 1917. JOHN K. BOYLE (right) is new assistant executive director of ACCA. He will continue his duties as director of Chamber's readjustment service. He joined Chamber in Sept. 1944. (Harris & Ewing and Del Ankers photos)

GLEN D. WOODMANSEE is new general counsel for CAA. A graduate of University of Utah, he came to Washington as a lawyer in solicitor's office in 1933. At that time he began working on early Bureau of Air Commerce regulations. When CAA was organized he became chief of enforcement section.

TOM M. GIRDLER resigned as chairman and director of Convair after more than 3 yr. service with that company. He continues as chairman of the board of Republic Steel. Under his leadership, Convair produced 25 percent of nation's heavy bombers by end of 1944 in addition to other types. (Acme photo)

C. W. FREITAG became regional representative on Convair's sales staff and will be stationed at Stinson div., Wayne, Mich. He learned to fly in 1926. During 1935-37 he was pilot and instructor for Amos and Andy, radio comedians, then he joined Howard Aircraft as sales manager and rose to v-p. and director.

M. E. STORER has joined Jacobson & Co., N. Y., maker of aviation engine test equipment, as executive engineer. Formerly with Wright Aero for 16 yr., he had been in charge of experimental engine test design. A personal pilot as well as engineer, he'll handle design and installation of Jacobsen products.

L. H. DENNIS has been appointed manager of CAL's newly created flight service department. His duties include planning, administering and directing all work pertaining to reservations, passenger, hostess, and food service. He comes to CAL from NATS, where he served in Pacific area as asst. operations officer.

HARRY T. NOWLAND has been elected first vice-pres. of Glenn L. Martin. A native of North Carolina, he was graduated from West Point military academy in 1923, and he became actively connected with Martin organization in 1936. He is also a vice-pres. of Glenn L. Martin-Nebraska Co., a wholly owned subsidiary.

O. J. KING has been appointed general manager of NWA's newly created eastern region, extending from Midwest to Atlantic seaboard. He had been general supt. of company's northern region where he aided ATC in setting up routes in Alaska and along Aleutians. He came to NWA in 1937.

FRANK AUSTIN is new supervisor of stations for Braniff Airways. His work will include general administration of stations, placement of personnel and equipment, and coordination of stations with other departments. Since Sept. 1937 he had been station manager and district traffic manager in Amarillo, where he was active in C. of C.

A. J. KLOSE has joined G. M. Giannini & Co. as v-p. and chief engineer in direct charge of reaction propulsion development in company's Pasadena experimental and development laboratories. He has been connected with design work on combat planes for Northrop, Avion, and Vultee. His most recent work has concerned jet propulsion.

SUMNER SEWALL, former Governor of Maine, has been elected president and director of AEA. A fighter pilot in World War I, he became an ace. For past 11 yr. he served as a director of UAL, a post he recently resigned. He was traffic manager of Colonial Airlines 17 yr. ago and subsequently was general passenger traffic manager of system which became AA. JOHN E. SLATER, (right) executive vice-pres. of AEA, was elected to executive committee of newly formed International Air Transport Assn. as one of two representatives of U. S. operators. He was a member of steering committee which drew up articles of organization for IATA. (Bachrach photo)

ROBERT C. TREADWELL became assistant general accountant for United Aircraft. Graduated from Harvard in 1926, he started with Storrs & Bement Co., then was connected with Hurdman & Cranstoun. Since 1941 he has been employed by Allen R. Smart & Co. as account manager specializing on United Aircraft accounts.

NEW PRODUCTS

KEEP POSTED ON *Products and Practices*

INFORMATION TIPS

This selected information on new publications and products is offered by the "AVIATION" Reader's Service through cooperation with the manufacturers. It helps executives save valuable time, provides profits through convenience. To obtain literature or additional data on new products described, simply fill in form below, clip it to your letterhead, and mail. There is no cost, no obligation.

ENGINEERING DATA

Cone-Drive Gears 1

Michigan Tool Co., Detroit, offers Bulletin No. 745, *Post-Graduate Course for Gears*, containing suggestions for designers of products in which right angle reduction gearing is to be used and recording wartime uses of cone drive gearing.—AVIATION, June '45.

New Publication 2

Describing company's latest achievements in scientific research, engineering and production *Newsfront*, new publication of Westinghouse Electric & Mfg. Co., Pittsburgh features new application of "precipitron" air cleaner for removal of fly-ash.—AVIATION, June, '45.

PRODUCTION

Electrode Chart 3

Comparing equipment from 22 manufacturers, chart of welding electrodes issued by Allis-Chalmers Mfg. Co., Milwaukee, contains information on stainless steel and hard surfacing electrodes and also mild steel type. Section is devoted to typical weld deposit analysis of stainless steel electrodes showing percentages of chromium, nickel, carbon, columbian, and molybdenum. Chart bulletin is numbered B6344A.—AVIATION, June, '45.

Parts Production Service.....4

Publication, *The Geometric Plan*, describes production service offered by Geometric Mfg. Service, Cleveland, which includes all details of production to order of stamped metal parts, welded subassemblies, or complete products.—AVIATION, June, '45.

Aircraft Products 5

Leaflet No. 5 from Pesco Products Div., Borg-Warner Co., Cleveland, describes line of aircraft products, including air equipment such as pumps and separators, fuel equipment, hydraulic units and related products.—AVIATION, June, '45.

Forgings 6

Production of forgings on contract basis is described in booklet, *Titusville Heavy Steel and Alloy Forgings*, issued by Titusville Forge Div., Struthers Wells Corp., Titusville, Pa.—AVIATION, June, '45.

Gear Production Service 7

Here Is Why, folder from Western Gear Works, Seattle, informs customers on war time service due to government demands.—AVIATION, June, '45.

Detergents 8

Available in alkaline, acidic, solvent and emulsion types, new detergents for metal cleaning are described in pamphlet from Optimus Detergent Co., Matawan, N. J.—AVIATION, June, '45.

Hose and Cable Clamps 9

'Punch Lok' safety clamps for banding hose and splicing cable are described in circular from B. F. Goodrich Co., Akron. Time-saving and safety features are stressed.—AVIATION, June, '45.

Screw Machine Products 10

Illustrating typical parts produced, involving screw machine and secondary operations heat treating, plating, cold upsetting, and thread rolling *Views on Federal Screw*, booklet from Federal Screw Works, Detroit, describes company service in contract manufacture of parts to customers' specifications.—AVIATION, June, '45.

Electrolytic Cleaner 11

Time and labor saving properties of 'Ferrodex 1' electrolytic compound made by W. D. Mac Dermid Chemical Co., Bristol, Conn., is topic of new company circular.—AVIATION, June, '45.

Aircraft Parts Catalogs 12

Aviquipo Mfg. Co., New York City, announces on the press catalogs as follows: No. A-104-F Army-Navy Aeronautical Standard Parts AN666 to AN669, also No. A-103-2 Army-Navy Aeronautical Standard Parts AN100 to AN170.—AVIATION, June, '45.

Hardenability Rule 13

Used in computing approx. hardenability of steel, new circular slide rule has been designed by Steel & Tube Div., Timken Roller Bearing Co., Canton, Ohio. Free copy is available.—AVIATION, June '45.

Glue and Veneer Staining 14

Perkins Glue Co., Lansdale, Pa., offers reprint of article, *Glues and Their Relation to Veneer Staining*, written in language of production man.—AVIATION, June '45.

Dry Cyaniding 15

Process of dry cyaniding in continuous furnaces is described in Bulletin SC-124 from Surface Combustion Corp., Toledo.—AVIATION, June '45.

Grinding Problems 16

Portfolio, *101 Grinding Problems Answered*, contains information for production men. It is issued by Dayton Grinding Wheel Div., Simonds Worden White Co., Dayton, Ohio.—AVIATION, June, '45.

Oil-Retaining Bearings 17

Comprehensive size list of oil-retaining bearings made by Bound Brook Oil-Less Bearing Co., Bound Brook, N. J., has been published to afford specifications of many thousands of parts from items listed.—AVIATION, June, '45.

Insert Locking System 18

New portfolio from Bardwell & McAlister, Hollywood, Calif., describes, and also contains cut-out illustrating, mechanical action of 'Rosan' threaded insert. There are also specifications of all types.—AVIATION, June, '45.

AVIATION READER'S SERVICE

AVIATION, 330 W. 42nd St., New York City 18

JUNE 1945

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NEW PRODUCTS:						65	66	67	68	69	70	71	72	73	74	75	76
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NAME ..... TITLE .....

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Silicone Insulation 19

Properties of DC 993 varnish and procedures in application to insulation of electrical equipment are given in booklet, *DC Varnishes*, by Dow Corning Corp., Midland, Mich.—AVIATION, June, '45

MACHINERY & ACCESSORIES

Transmissions 20

Designed for motorization of lathes, milling machines, and many other types of belt-driven machinery, transmissions up to 30 hp are described and applications shown in folder from Western Mfg. Co., Detroit.—AVIATION, June, '45

Brazing Procedure 21

Low Temperature Brazing Notes, No. 31, publication of Handy & Harman, New York City, describes procedure in changeover from hydraulic aircraft brake cylinder of magnesium casting to brazed construction of thin wall steel tubing.—AVIATION, June, '45

Carbide Tools 22

Stock list of carbide tipped and solid carbide tools—Bulletin No. 115—is available from Tungsten Carbide Tool Co., Detroit.—AVIATION, June, '45

Lift Trucks 23

Hyster Co., Portland, Ore., has issued catalog covering line of pneumatic tire lift trucks. Applications are shown and specifications given.—AVIATION, June, '45

Inside Micrometers 24

Inside micrometers made by Tubular Micrometer Co., St. James, Minn., are described in new catalog page.—AVIATION, June, '45

Rivet Manual 25

New manual from Cherry Rivet Co., Los Angeles, covers description, installation tools, and inspection procedure in use of blind rivets.—AVIATION, June, '45

Equipment and Tools 26

Oil and fuel lines, fittings, shut-off cocks and many other parts with tools and equipment for cutting, flaring, and soldering are described in 82-page catalog from Imperial Brass Mfg. Co., Chicago.—AVIATION, June, '45

Push-Button Units 27

Indicating lights, selector switches, and push-button units for built-in machine tool applications are described in publication No. OEA 4254 from General Electric Co., Schenectady, N. Y.—AVIATION, June, '45

Welding Technique 28

Describing methods of welding with Ampco-Trode electrodes and containing sections on metallic arc, carbon arc, and oxy-acetylene welding, Bulletin No. W-2 titled *Ampco-Trode Welding Technique*, has been issued by Ampco Metal, Milwaukee.—AVIATION, June, '45

Electronic Riveter 29

Sloco Mfg. Co., Detroit, maker of electronic "Elvitor," announces in circular new "Victory" adjustable backing bar used in conjunction and made to fit any job.—AVIATION, June, '45

Luminous Material 30

New luminous product called "Everglow" described as having wide field of applications, particularly for emergency lighting in case of lighting system failure, is announced by Half-Vesole Co., St. Paul, Minn. Features are stated to be: Well balanced luminous material, good initial intensity, long light life, and excellent stability.—AVIATION, June, '45

Industrial Trucks 31

Condensed catalog folder containing specifications of hand and power lift industrial trucks is offered by Automatic Transportation Co., Chicago.—AVIATION, June, '45

Portable Hand Tools 32

Described in catalog is line of Skilsaw portable electric hand tools made by Skilsaw, Inc., Chicago. Included are electric drills, saws, sanders and grinders in wide variety of sizes and types.—AVIATION, June, '45

Chain Belts 33

Table top chain belt for conveyors is described in Bulletin No. 461 from Chain Belt Co., Milwaukee. Flat top has applications to manufacture of small parts.—AVIATION, June, '45

Arc Welding Equipment 34

How to Select Equipment for Unionmelt Arc Welding is title of booklet from Una Welding, Cleveland, in which is listed information on direct current, alternating current, open arc, protected arc, and concealed arc types.—AVIATION, June, '45

Disk Grinder 35

Kindt-Collins Co., Cleveland, offers Bulletin B-1 on Model 32L 30-in. hydraulically operated disk grinder for pattern and other work, and on Model 60H for heavy duty work.—AVIATION, June, '45

Precision Thread Grinding 36

Multi-form wheel method of thread grinding on precision parts for aircraft is described in Bulletin No. M-100-140 issued by Sheffield Corp., Dayton, Ohio. Detail illustrations are included and specifications of tools and machines given.—AVIATION, June, '45

De-Burring and Finishing 37

"Roto-Finish" mechanical method of de-burring and finishing metal parts is described in folder from Sturgis Products Co., Sturgis, Mich.—AVIATION, June, '45

Machining Hardened Steel 38

Booklet on "Hardsteel" tools from O. A. Mussa Co., Newark, N. J., describes product and its applications, also gives information on drill speeds and procedures, and sizes. Included is hardness-conversion table.—AVIATION, June, '45

Hand-Tool Catalog 39

Celebrating its 20th anniversary, Snap-on Tools Corp., Kenosha, Wis., has issued new and complete catalog. Company manufactures many types of hand tools as well as bench grinders, tool chests, and portable benches. Catalog contains complete specifications and suggestions to mechanics.—AVIATION, June, '45

Tool Blanks 40

Available in all standard sizes having thicknesses of 0/16 in. or more. Style S-900 tool blanks, made by Kennetal, Inc., Latrobe, Pa., are described in Catalog Sheet 32-A.—AVIATION, June, '45

Soldering Tools 41

Folder from Ideal Commutator Dresser Co., Sycamore, Ill., details "Thermo Grip" electric soldering tools, described as quick-acting since work, as well as tool, is heated almost instantly.—AVIATION, June, '45

Inspection Check Gage 42

Comlor Co., Waltham, Mass., announces Model P-3 "Centergrip" amplifier containing new shock-absorbing movement designed to protect mechanism from shocks while in use at bench or machine. Offered is Bulletin No. 31 which states new movement can be applied to older P-1 models.—AVIATION, June, '45

Scarfing Machine 43

Containing suggestions for stretching limited supplies of woods such as by salvaging of short board ends, Bulletin 1113 from Oneida Machine Works, Chicago describes No. W-242, scarfing machine.—AVIATION, June, '45

Pneumatic Rotary File 44

Circular from Forss Pneumatic Tool Co., Rockford, Ill., describes pneumatic rotary file and die grinders, Models 1047 and 2000. High speed and power small size, and light weight are features.—AVIATION, June, '45

For Welding Students 45

Setting Up a Victor Welding or Cutting Unit is title of booklet from Victor Equipment Co., San Francisco, Calif., designed for use of welding students or beginners.—AVIATION, June, '45

Electroplating 46

"Rectoplater", junior and senior sizes, containing the magnesium-copper sulphide type of rectifier, is new source of electroplating current, manufactured by Udylite Corp., Detroit, and described in circular.—AVIATION, June, '45

Boring Machine 47

Pamphlet from Hydre-Borer Div., Air-Parts, Inc., Glendale, Calif., describes precision boring machine.—AVIATION, June, '45

Cable Voicepiper Kit 48

For cable repairs, new kit, both portable and bench type, is described in folder from Mines Equipment Co., St. Louis.—AVIATION, June, '45

Air Circulator 49

Information is available on new type air circulator for use in offices and factories. It is stated that the plastic propeller does not conduct noise from motor. Air induction flanges and new type propeller actuate vortex action, like that of funnel of tornado. Maker is Vornadofan, Div. of A. Sutten Corp., Wichita, Kan.—AVIATION, June, '45

ELECTRICAL

Electric Timers 50

Describing table and wall model stop clocks, chronoscopes, combination timers, and impulse counters, Bulletin No. 1190 has been issued by C. H. Stoelting Co., Chicago.—AVIATION, June, '45

Resistors 51

Ohmite Mfg. Co., Chicago, offers full information on Series 82 and 83 "Ritsohm" precision resistors.—AVIATION, June, '45

Electrical Insulation 52

Continental Diamond Fibre Co., Newark, Del., is mailing Bulletin ED-44 containing testing data, properties, forms, graphs, fabrication, design, and uses of its line of electrical insulating materials.—AVIATION, June, '45

Radio Tube Chart 53

Wall chart listing receiver-type radio tubes with information to enable best selection for specific applications has been prepared by Sylvania Electric Products, New York City.—AVIATION, June, '45

Batteries 54

Willard Storage Battery Co., Cleveland, offers General Catalog, Section 6, containing information on aircraft batteries.—AVIATION, May, '45

AVIATION INSTRUMENTS

Photogrammetric Instruments 55

In brochure, Abrams Instrument Co., Lansing, Mich., describes aerial mapping and photographic services, also instruments cameras, and materials for use in such work.—AVIATION, June, '45

PLASTICS & SYNTHETICS

Plastic-Fabricating Manual 56

Handbook, *Fabricating Methods for Lumarith, Celluloid, and Similar Thermoplastic Materials*, issued by Celanese Plastics Corp., Div., Celanese Corp. of America, New York City, contains complete information, including primary and secondary cutting procedures, fabricating of film, foil, and sheet stock; various molding processes; and methods for finishing articles. Edition is limited.—AVIATION, June, '45

Coated Fabrics 57

Technical booklet on "Fairprene" coated fabrics, issued by E. I. du Pont de Nemours Co., Fairfield, Conn., describes product lists qualities and physical properties, and includes 21 samples.—AVIATION, June, '45

Plastics Bulletin 58

Forms, applications, and properties of plastics manufactured by Plastics Dept., E I Du Pont de Nemours Co, Arlington, N. J., are subjects covered in bulletin *Du Pont Plastics*—AVIATION, June '45

STEELS

Aircraft Steels 59

Manual containing data on all types of cold rolled strip, wire, and wire products for use in aircraft construction has been issued by American Steel and Wire Co. Cleveland. Explained is nature and characteristics of control cables, also intricacies of splicing and swaging. Weight and strength data are included, also general engineering tables.—AVIATION, June, '45

AIRCRAFT PRODUCTS

Cabin Air Filter 60

Filtair, Inc., Glendale, Calif., has released information on cabin air filter stated to be capable of passing 1,250 cu. ft. of air per min., with drop of less than 1/8 in. in pressure in given area.—AVIATION, June, '45.

AVIGATION

Avigation System 61

Catalog containing description of courses, instruments, and books with illustrations, and specifications of equipment and charts, has been issued by Weems System of Navigation, Annapolis, Md.—AVIATION, June, '45

MANAGEMENT & EMPLOYEES

Chart of Business 62

Business ups-and-downs since 1775, including various data, are shown graphically on chart from Ex Cell-O Corp, Detroit.—AVIATION, June '45

Electrical Distribution 63

Graybar Electric Co, New York City, has issued booklet, *Tomorrow's Electrical Distribution—Via Graybar*, which describes company's plans and services in the industry.—AVIATION, June '45

Fire Extinguisher Guide 64

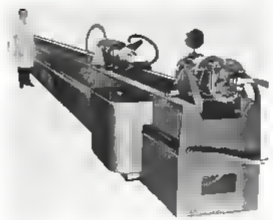
Chart offered by Randolph Laboratories, Chicago, illustrates correct types of fire extinguishers to be used in controlling fires of various kinds.—AVIATION, June, '45

NEW PRODUCTS

Latest Machinery

Straightening Machine 65

Particularly useful for straightening rolled and extruded metal used for aircraft fuselage stringers, new hydraulic



stretch-leveling table, made by Hufford Machine Works, Redondo Beach, Calif., handles sections up to 40 ft. in length, of any shape and many materials. It not only straightens stock by establishing a "set" in metal through slight pre-determined stretching, stakes maker, but also can be used in conjunction with die for stretch-forming to contours up to 30 deg. Machine has pull cap of 40 tons with 18 in. stroke on each piston but it can be built in higher or lower cap. Machine consists of two hydraulic tandem cylinders mounted in steel brackets attached to steel bed. Cylinder at control end is stationary, while opposing cylinder is adjustable along length of table in 6-in. increments. Both cylinders, which tilt upward to max. of 30 deg. are actuated and positioned by small auxiliary cylinder assemblies. Piston rods are equipped with air operated gripper jaws.—AVIATION, June, '45

Metal Cleaning Machine 66

Utilizing airless abrasive blasting unit, "Wheelabrator" swing table made by American Foundry Equipment Co., Mishawaka, Ind., is reported to extend speed and economy of airless blast cleaning to wide range of intricate or irregularly shaped work. Work is placed on rubber-covered table mounted on door of blast cabinet. As door is closed table swings into cabinet under blast unit and is rotated at predetermined speed. Unit whips continuous stream of abrasive down upon rotating work to full width of table. Sizes with work table of 24, 32, 72, and 86-in. dia. are available.—AVIATION, June, '45

Automatic Miller 67

Milling circular, partial and dome fins on forged aluminum cylinder heads of aircraft engines, jobs said to have required four machines and four separate operations, are now reported to be done on one special machine in two operations. New machine designed by Sundstrand Machine Tool Co., Rockford, Ill., is controlled hydraulically and electronically and has completely automatic cycle after loading, operator merely pressing control button at start. Maker states that there is no waste motion or cutting of air under irregular cutting inasmuch as adjustments are positive and cutter can be set to rapid approach to within ⅛ in.

of each fin. Machine is arranged for adaption to either individual or central coolant system. Work is totally enclosed during cutting cycle.—AVIATION, June, '45

Shop Equipment & Materials

Band Saw Lubricant 68

Offered in stick form, band saw tooth lubricant made by Kinsel-Collins Co., Cleveland, is applied by pushing stick against saw teeth while in motion. It is reported to aid cutting action and prevent chips from clogging teeth.—AVIATION, June, '45

Air Tool Lubrication 69

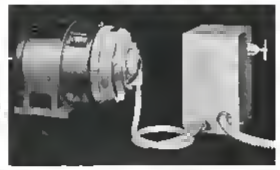
Less maintenance and longer life for air driven tools are reported resulting from use of "Air Lubell," lubricant made by W. C. Wallers Co., Glendale, Calif. Basic oil is combined with detergent for cleaning moving surfaces, dispersed being stated to prevent deposit of sludge and inhibitant described as preventing formation of organic acids.—AVIATION, June, '45

Bank-Type Resistor 70

In new "Regan" bank-type resistor, made by Teahlmann Industries, Milwaukee, 6 resistors in bank are standard, but they can be built from 2 to 24 in bank. Dimensions of 6-bank resistor are: Frame length 23 in., frame width 11¼ in., and frame depth 4¼ in. Each additional resistor adds 6 in. to length of frame, and each less than 6 shortens frame by 3 in. Parts, it is stated, can be purchased separately and repairs made quickly.—AVIATION, June '45.

Pneumatic Disk Brake 71

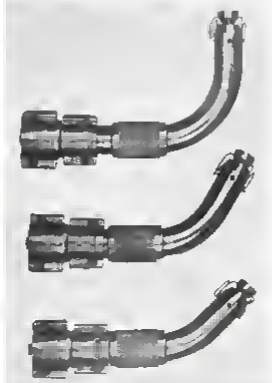
Designed to provide quick, smooth stop of motors or other rotating equipment, improved line of pneumatic disk brakes has been announced by James L. Entwhistle Co., Pawtucket, R. I. Brakes include adjustable torque-control unit which permits instantaneous adjustment of braking torque from remote positions without change of brake adjustment. The



two rotating members require no lubrication and no adjustment during life of friction disk. Brake requires 1/40 cu. ft. of air or less per operation and can be mounted on any machine where shaft extension and flat mounting surface can be supplied. There are no packings. Brakes are available with or without control unit in single, double or triple disk with torque ratings of 100, 200 and 300 lb.-ft. for operation up to 125 psi.—AVIATION, June, '45.

Sound Riveter 72

For use on the hard-to reach rivet, Topflight Tool Co., Towson, Md., has developed new round riveter, made in four standard models and in special sizes to order.—AVIATION, June, '45

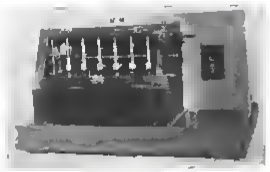


Linear Indicator 73

Stated to indicate, in linear response on screen of cathode ray oscillograph, the pressure-time curve of any internal combustion engine, pump, airline, or other enclosed pressure system, new electronic device called "Pressuregraph," manufactured by Electro Products Laboratories, Chicago, measures either static or dynamic pressures. In operation, pickup section is inserted in cylinder, chamber or airline. Pickup response is transmitted after amplification to screen, only one control being required.—AVIATION, June, '45.

Precision Tool Holder 74

Shearcut Tool Co., Bellingham, Wash., announces development of precision tool holder for use with company's "Shearcutter" metal cutting tool. Holder is made in 6 sizes for lathes and screw machines from 16 to 36 in. swing. Each holder is furnished with 3 boring bars, one for turning in smaller sizes and two for turning and boring.—AVIATION, June, '45



Ball Bearing Cleaner 75

Equipped with six jets which clean six bearings at same time new machine for washing and cleaning ball bearings made by Strata Instrument Co., Long Island City, N. Y., utilizes centrifugal force and liquid pressure only—AVIATION, June, '45

Twin-Fluted Countersinks 76

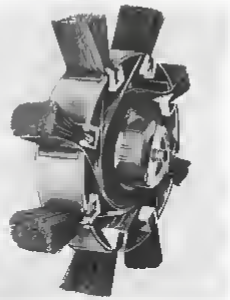
Recommended for cutting aluminum, magnesium steel plastics, and plywood, twin-fluted countersinks made by Greset File Co., New York City are provided in 8 piece sets giving six sizes with duplicates in two sizes. Tools are reported to make perfect chamfer, free from ridges or chattermarks. Standard set is made with 41 deg. o/l angle but may be obtained with 45 and 30 deg. angle c/l—AVIATION, June, '45

Universal Joints 77

Operating at speeds up to 6-000 rpm between shafts subject to max deviation from normal of 6, high-speed constant-velocity universal joints developed by Gear Grinding Machine Co., Detroit are reported to deliver to driven member same constant speed of rotation provided by driving member at all speeds and at all angles of deflection—AVIATION, June, '45

Brush-Backed Sander 78

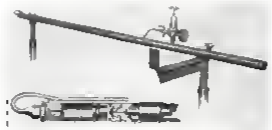
Described as being adaptable to former hand jobs, brush-backed sanding wheel called "Sand-O-Flex," made by Exactone Tool & Die Co., Hollywood, Calif., sands deburrs, finishes wood, metal, plastics, rubber and other materials. Wheel consists of central magazine housing strip abrasive. Eight of these strips extend through housing and are held against



work by tough bristles which cushion abrasive, making it possible to reach in and around hard-to-get at places. Overall dia., including brushes is approx. 8 in. and weight is 2¾ lb. Wide range of abrasives are supplied. Brush fits all standard ⅛ and ¼ in. motor shafts or can be made to fit other sizes. Motor of ¼ hp will handle all normal operations, as will most portable electric tools. Motor speed of 1,750 rpm. is recommended for fine sanding—AVIATION, June, '45.

Bar Feed 79

Manufactured in seven sizes to take bar stock from 6 to 11 ft. long, new bar feed made by Newton Mfg. Co., Los Angeles is complete unit including stands, seamless tube pressure regulator, and pistol. Air line connects to regulator which actuates piston, pushing stock into lathe stop under uniform pressure. Pressure regulator may be quickly adjusted for various stock weights. Forward end



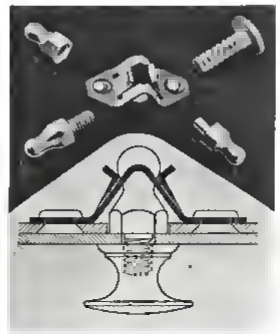
of piston is inverted cone shape, mounted on end-thrust ball bearings, which centers stock and turns with it, holding it away from stock tube, eliminating noise. To operate, tube lock is released by turn of hand knob, tube is swung over on slide bracket, bar stock inserted, and tube returned to position and locked.—AVIATION, June, '45.

Crush Dresser 80

Available in two styles and applied either to new machines or to those in use, electrically powered crush dressing device for forming the wheel on thread and form grinders made by Sheffield Corp., Dayton, Ohio, is described as saving time and increasing life of crusher roll. With Model A, operator presses button after crusher roll has been manually lowered into contact with grinding wheel. When feed indicator dial shows that desired depth of dressing has been reached, operator releases pressure on push-button, stopping all operations, then lifts crusher out of wheel engagement and grinding of work continues. Model B is semi automatic in that feed dial indicator is pre set for desired depth of automatic in-feed of crusher roller. After removal of wheel guard and lowering of roll, closing of electric switch starts operations which are stopped automatically when desired depth of in-feed is reached—AVIATION, June, '45.

Spring Steel Latch.....91

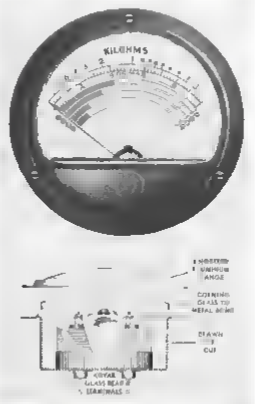
For quick attachment and removal of box covers, access doors, panels, and inspection plates, spring steel Speed Nut latch No. 1643 has been developed by Tinnerman Products, Cleveland. Spring arms of cut snap over ball or grooved



studs to provide attachment. Studs may be quickly withdrawn. Speed Nut is available to five material thicknesses, and three styles of ball studs may be had—drilled and tapped for 6-32 screws, threaded shank (6-32 thread) and plain shank for riveting—all in various lengths to fit different types of work encountered. —AVIATION, June, '45.

Hermetically Sealed Meters.....92

Reported to have achieved true hermetic sealing in 2½-in. and 3½-in. electrical indicating instruments Marian Electrical Instrument Co., Manchester N. H., builds mechanism into protective cup like frame, then seals glass cover to metal rim. No rubber gaskets or cement seals are used. Maker states instruments can be immersed in boiling brine for



weeks, or frozen to minus-40 deg. F., without deterioration of seals. Windows are double thickness tempered glass processed for solder sealing. Completely hydrated, instruments are filled with dry air at sea level pressure. Magnetic shielding permits interchangeability on any type panel without affecting calibration. Employed are silver-clad beryllium copper hair springs, glass bead type terminals, and phosphate finish.—AVIATION, June, '45

Resin Adhesive 83

Having improved features for low-pressure wood assembly work in aircraft Uraco 153 new craze resistant urea-formaldehyde resin adhesive developed by Plastics Div., American Cyanamid Co., New York City, is described as greatly reducing problems of crazing and fine cracking of glue. Other advantages reported: Greater storage stability, elimination of amylaceous fillers, control of glue line pH to values acceptable under certain specifications, lower cost, and provision of hardener system for summer use. Glue line thicknesses up to .020 in. may be tolerated in low-pressure bonding.—AVIATION, June, '45

Light Metals Technique 84

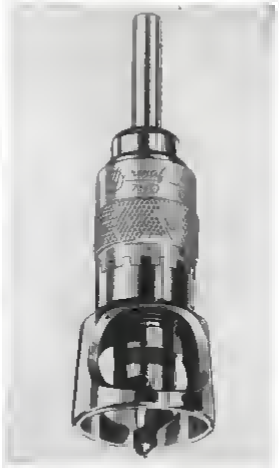
Aircraft Products Mfg. Corp., Des Plaines, Ill., has developed improved production service technique in machining aluminum and magnesium parts through use of special machines with versatile, interchangeable attachments described as eliminating many tools and fixtures usually used. Sequence of operations such as surfacing, boring, milling, and drilling, can be done at one setting, four heads being mounted on master head of machine. Coordination of special head combinations with Vernier scales built into machine is reported to provide jig bore precision between related surfaces.—AVIATION, June, '45.

Laminated Plastic 85

Stated to work easily for deep drawing of intricate parts, "Lamecoid" in sheet form is now available. Sheets are 40 x 42 in. and are 1/32 in. or over thick. Type E-527 is for deep drawing, while E-528 is for ordinary forming and shallow drawing. Maker is Mica Insulator Co., New York City.—AVIATION, June, '45.

Ball Skirt Countersink 86

Designed to give added base support for better tool alignment and greater chip clearance, new large ball skirt micro-set



countersink is announced by Aircraft Tools, Los Angeles. Model AT-400-B is stated to be compact and of light weight. Shaft runs in "Oilite" radial bearing with ball bearing thrust. Countersink takes up to ⅝ in. cutters.—AVIATION, June, '45.

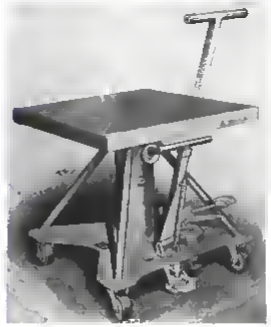
Dust Collector 87

Described as able to collect and retain any type of fine dust or lints with high efficiency, tubular "Duetex" collector made by Duet Filter Co., Chicago, is portable and self contained. Large unit contains 45 sq. ft. of filter surface area with smaller units in proportion. No collector bags are used, dust filtering through tubular and bottomless filters drops into pan.

Unit maintains static air pressure of more than 4 in. at velocity of over 5,000 lin. ft. per min. Units weigh from 150 to 250 lb., and they are 36 to 48 in. high. Motors are a.c., ¾ and 2½ hp.—AVIATION, June, '45.

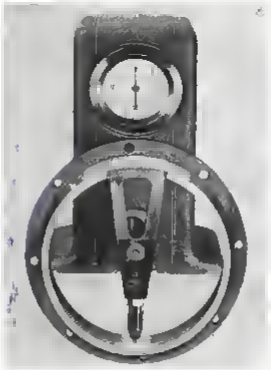
New Type Elevating Table 88

Hydraulic elevating table made by Lyon-Raymond Corp., Greene, N. Y., features a telescopic sewing handle. Extended, handle provides means for easily moving table. Collapsed, handle is below and under table top.—AVIATION, June, '45.



Hole gage 89

Illustrated is large bearing housing being checked to close tolerances by use of "Hole Checker" made by American Gage Co., Dayton, Ohio. Special sizing plug is used with upper part finished to exact



radius of inside of housing. Lower part carries angina head, which is calibrated for high and low limits of accuracy. Contact point is polished norbide. Unit is air-operated and it is set with high and low limit master ring gages. Tolerance is .0003 in.—AVIATION, June, '45

Electrical Appliances

15,000v. Power Control Tube 90

Thyratron WL-678 is a 15,000v power control tube which provides split-cycle control of high power for R.F. heating units and radio transmitters. Its use is stated to make possible smooth and instantaneous control from 0 percent to 100 percent load, simplified automatic load control, high speed automatic overload protection, low space and weight, and low control power requirements. It is stated that grid-controlled mercury vapor rectifier tube is designed to combine high voltage characteristics of a Kenotron control qualities of a Thyratron, and efficiency of a Phanatron. Maker is Westinghouse Electric & Mfg. Co., Lamp Div., Bloomfield, N. J.—AVIATION, June, '45.

Accelerometers 91

Stratham Laboratories, Los Angeles, announces series of accelerometers sensitive elements of which are unbonded strain sensitive filaments in grid form, constituting sole support for the mass. Filaments are connected in a Wheatstone bridge circuit of which all four arms are active. Bridge circuit is balanced in assembly, and there are four electrical terminals, one at each corner of bridge. Small dry cell battery is connected to two of them, other two being connected directly to recording galvanometer. No amplification is required, due to method of support of wires. Natural frequencies vary from 100 to 1,000 cyc. per sec., with 12 G accelerometer having a natural frequency of 400 cyc. per sec. Weight is 2 oz. Instruments are linear within 0.5 percent. Sensitivity to transverse acceleration is less than 0.1 percent. Zero drift with temperature is less than 1 percent between plus-100 and minus-50 deg. F.—AVIATION, June, '45

Open Blade Switch 92

Single-pole open-blade switch made by Acro Electric Co., Cleveland has beryllium rolling spring and measures approx. 2 1/32 x 10/10 x 23/64 in. Standard operating pressure at end of blade is 3 to 6 oz. Switch is rated at 15 amp. 115v. a.c. Contact arrangements are for normally open, normally closed, or double-throw circuits.—AVIATION, June, '45

Thermostatic Switch 93

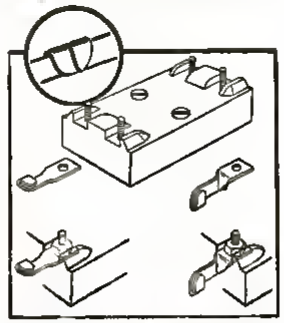
Particularly suited for mounting on bottom of electrically heated equipment such as glue pots and hot plates, where manual "on" and "off" knob is desired, new dual cam-adjusted thermostatic switch, made by George Ulanet Co., Newark, N. J., is usable for either or both thermostat and manual switch, permitting instant adjustment of thermostat. By lengthening cam shaft, knob may be located any distance from thermostatic element. Pointer on knob can be set at any desired temperature. Unit is available in 50 to 300, 50 to 450, and 50 to 700 deg. F. ranges. Rating is 1,500w., 115-660v. a.c.—AVIATION, June, '45.

Portable Insulation Tester 94

Having wide range of test uses, from wiring of small appliances up to major power units, 47-lb. portable insulation tester measuring 18 x 7¼ x 9¾ in., manufactured by General Electric Co., Schenectady, N. Y., may be plugged into any 115v, 60 cyc. outlet, and will supply variable test voltages from 0 to 2,500. Set has capacity of 750v-amp. and will, it is stated, stand 1 min loads of 1,500v.-amp. Voltmeter supplied from separate coil on transformer winding, is arranged to give full-scale readings at either 2,500 or 1,250v.—AVIATION, June, '45

Solderless Wiring Adapters 95

Conversion of any existing electrical assembly to use with knife-disconnect splicing terminals manufactured by Aircraft Marine Products, Harrisburg, Pa., is possible, states company, through use of its special adapters which are installed in assembly in same manner as solder tab it replaces. Adapters for vertical or horizontal conversion for wire sizes from 22 to 10 are available.—AVIATION, June, '45.



Sealed Resistors 96

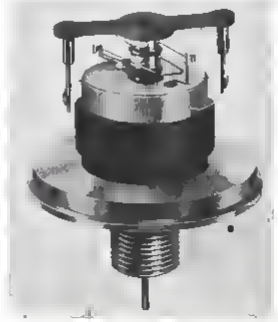
Described as impervious to moisture, fungus, vibration, and rough handling, new type No. 1100 Series hermetically sealed accurate-tolerance wire-bound resistors manufactured by Shallcross Mfg. Co., Collingdale, Pa., are constructed without glass, without floating or stud-locked resistance elements, and without ferrule terminals or caps. Using standard mounting facilities, they are available in two designs and all values from 1,000 ohms to 10 megohms. Resistance form and protective shell are of ceramic. Resistance winding element and outer shell are a complete unit without internal leads or floating wires. Seals are solder. Windings are standard noninductive pie type. Terminals are standard solder lug type.—AVIATION, June, '45.

High-Voltage Capacitors 97

For high temperature high-voltage applications, Sprague Electric Co., North Adams, Mass., offers capacitors employing "Vitamin Q," special oil-impregnant described as retaining all virtues of conventional units throughout extreme range of plus-105 deg. to minus-40 deg. C. Leakage resistance at room temperature is stated to be 20,000 megohms. Types include metal container styles for 85 deg. and 105 deg. C. continuous operation, and in d.c. rated voltages from 1,000 to 10,000v. There is also Type 42P sealed in glass.—AVIATION, June, '45.

High Sensitivity Resistors 98

Suitable for connecting directly to sensitive low-torque apparatus, such as aircraft flight test recording instruments,



"Autoflight" high-sensitivity resistors made by G. M. Giannini & Co., Pasadena, Calif., measure 2¼ by 1 1/16 in. dia. Operation is from simple d.c. source and no amplifiers are required. Available in types from 100 to 1,500 ohms, and from 4 to 16w., they require but 8 gram-milli meters input torque to overcome friction.—AVIATION, June, '45

Aircraft Parts & Field Units

Soil Stabilizer Machine 99

Stated to combine in one operation all necessary functions in soil preparation, machine called Single Pass Stabilizer, made by Harnischfeger Corp., Milwaukee, is described as making possible faster, more economical construction of airport runways and parking lots.—AVIATION, June, '45.

Cable Connector Tool 100

For use in installing copper and aluminum "Hydent" connectors on large cables, Burndy Engineering Co., New York City, has developed hand tool called "Hytool" MY28, which can be used on aircraft cable, sizes No. 8 to 4/0, and other cables. An adjustable holding die accommodates entire range of connectors. Weight is 6½ lb.—AVIATION, June, '45

Engine Oil Filter 101

In using the "Hyflow" portable aircraft engine oil filter manufactured by Hilliard Corp., Elmira, N. Y., used oil is drained from engine to dirty oil tank. Gasoline engine driven pump withdraws oil from tank, forces it through heater and next through large filter elements, filtered oil then being delivered to clean oil section of tank. Gasoline engine also drives pump to deliver cleaned oil to aircraft engine, meter in oil line registering quantity returned. Temperature regulators and flow control valves are automatic. Cycle is stated to require only few minutes.—AVIATION, June, '45

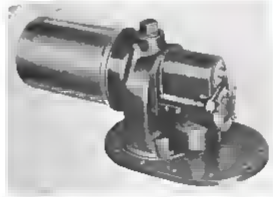
Fuel Pump Seals 102

Formed by compression molding of bronze powder, seals for aircraft fuel pumps are described as being made to closer tolerances and at lower cost by Keystone Carbon Co., Powder Metal Parts Div., St. Marys, Pa.—AVIATION, June, '45.

Water Injection Pump 103

Requiring less than 1¼ lu. of space outside tank for mounting purposes, new fully enclosed water injection pump for aircraft made by Romec Pump Co., Elyria, is gear driven.

Ohio supplies water or water alcohol mixtures vaporized in combustion chamber. Special internal insulation and external contact insulation are stated to prevent corrosion. Through special engineering of unit for wide temperature



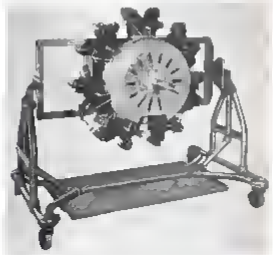
ranges heat dissipation is high, and this feature plus agitation caused by relief valve discharging directly into tank is stated to reduce freezing hazard. Photo shows Model RD 8500A, with supercharger connection.—AVIATION, June, '45.

Single Crystal Transmitter 104

Suitable for any type of mobile service and quickly convertible from amplitude to frequency modulation 8-channel transmitter designed by **Bendix Radio Div., Bendix Aviation Corp.**, Baltimore, can be set for any frequency in 100-156 megacycle band, and it uses but one crystal. New 8-digit 8-channel automatic shifter is used. Number of dials can be varied on basic design from 1 to 10, and as high as 16 channels could ultimately be incorporated into design. On any one of 8 channels frequencies are determined by dial calibration without use of crystal frequency indicator.—AVIATION, June, '45.

Engine Overhaul Stands 105

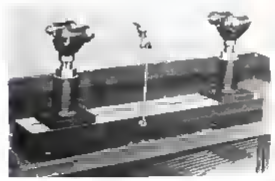
For promoting efficiency and precision in dismantling, assembly, repair and overhaul operations on aircraft engines,



new engine overhaul stand made by **Clayborne Mfg. Co.**, Chicago, handles all popular makes of radial and horizontally opposed engines up to 220 hp. Engine balance is obtained by raising and lowering mounting frame.—AVIATION, June, '45.

Crankshaft Aligning Fixture 106

For use in checking aircraft engine crankshafts not designed with internal spline feature also propeller shafts and assembled crankshafts, aircraft engine



crankshaft aligning fixture has been developed by **Airplace Mfg. & Supply Co.**, North Hollywood, Calif. Dimensions 30

in long, 8 in. wide and 18 in. to top of bearing-mounted V-blocks.—AVIATION, June, '45

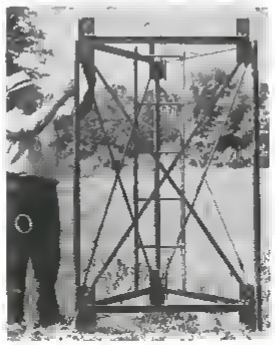
Safety Hook Latch 107

Reported to give 60 percent of full throat opening, improved latch for safety hooks used for lashing and handling aircraft cargo, is announced by Thomas Laughlin Co., Portland, Maine. Load can-

not be removed until catch is released. If overcrowded, latch will not seat into place, and if hook spreads because of excess load, latch pops up as signal.—AVIATION, June, '45

Radio Tower 108

Bolt and sleeve construction in Blizzard King radio or structural tower made by Harsco Steel Construction Co.,



Elizabeth, N. J., is designed to eliminate need for skilled labor. Average weight of members is 5.8 lb. Designs range from 55- to 485-ft. heights.—AVIATION, June, '45

Distant Reading Compass

(*Continued from page 177*)

The master unit will function correctly with angles of bank or pitch up to 75-deg. This is greater than the maximum permissible under normal flight conditions, but in cases of emergency or during violent evasive action this limit may be passed. Accuracy of the compass can be restored by switching to "setting" for a short period.

Part of the story of the new instrument is its use in connection with other avigational instruments. The advantages of having an accurate compass to control the automatic pilot are obvious. And among the accurate settings necessary in order that the automatic computor in the bombsight may function properly is the course the airplane is flying. This is set by means of a repeater from the compass similar to the repeater compasses in other parts of the craft.

Without it the air position indicator would not work. The air position indicator, operating in conjunction with the distant reading compass and the air mileage unit, shows the avigator (on continuously rotating counters) the air position of the airplane at any moment in terms of latitude and longitude, the avigator then applies the wind to this and he has his exact geographical position.

Development of the Distant-Reading Gyro-Magnetic Compass has enabled crews of Allied warplanes to fly extreme distances with the certain knowledge that they would be able to find their target and, after bombing it, get on the right course for home without flying straight and level over heavily defended areas in order to let the compass settle down.

While at present the instrument's importance to military flying is stressed, its value in tomorrow's commercial aviation—when bad weather will remain as an enemy—can be readily appreciated.

Prime Rate Is Seen for Gas Turbine

(*Continued from page 133*)

from takeoff to dive maximum. Throughout this speed range, fuel is burned at practically a constant lb per hr rate, and changes in speed have but little effect on thrust or fuel consumption. Further, the jet propulsive efficiency is approximately proportional to speed—shown in Fig. 5. These factors will lead to the use of jet engines in high speed craft. At low airspeeds, fuel consumption rates are exorbitant compared with propeller-driven craft.

To offset the disadvantage of low efficiency at low speeds, the jet engine delivers much power for very low in-

stalled power plant weight, in its proper flight speed range, cycle efficiency, while not good, is fair, which means low fuel cost per thp. at very high speeds, and the engine's diameter is sufficiently small to permit buried installations in the wings of any but the smallest planes.

Apart from booster applications in aircraft that are underpowered with reciprocating engines, jet engines should not be installed in any but the cleanest of low drag planes. Most suitable applications for jet propulsion appear to be in speed ranges where compressibility effects are the principal unknowns. Supersonic problems are fairly well known from ballistics, and low speed flight has been well explored, leaving a large blank for the natural flight speed range of the jet engine. And it is probable that jet propulsion will serve as the incentive and tool to fill this gap in our knowledge.

To project our present designs somewhat into the future and estimate possible trends, Fig. 12 has been prepared. The solid curves represent power-required and power-available characteristics of an extremely fast high altitude single seater of current reciprocating engine design, the dotted curves are for a jet propelled plane of equal gross weight and wing area but in which it is assumed that the drag has been reduced by half through refinements made possible by use of the jet engine.

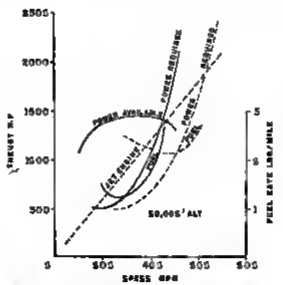


Fig. 12. Power-required and power-available curves for single engine plane with reciprocating engine (solid lines) and jet engine (dotted lines). Fuel consumption rates for both aircraft are shown.

The maximum speed at 20,000 ft. increases from 460 mph. for the conventional plane to approximately 600 mph for the jet fighter, assuming that compressibility effects are absent, but the speed increase does not bring with it a better cruising radius even when proper allowance is made for the larger fuel tanks that are permitted by the lighter weight jet engine. The lowest fuel rate in lb. per mi. at this altitude

for the jet plane is almost double that of the conventional aircraft

By increasing the altitude of the very low drag jet plant of Fig. 12 to 30,000 ft, the maximum speed may decrease slightly due to compressibility effects but the best cruising speed is increased by about 50 mph with a fuel consumption per mile about 40 percent greater than the conventional plane. The conventional craft with a high maximum speed is able to throttle back to a 270 mph cruise for maximum range. The jet plane will have to fly at over 500 mph. for maximum range, and high speed always means very large power expenditures—a point often overlooked by rocket and jet enthusiasts. However, this jet plane would fly the same course in half the time that the conventional craft would take, and could, therefore, afford a reduction in range for interceptor service and related missions

These estimates are based on the rather optimistic assumption of a jet plane with only half the drag of the plane with conventional power plant installation.

Fig. 13 is a bar chart comparing the relative merits of a jet fighter and conventional fighter with regard to takeoff

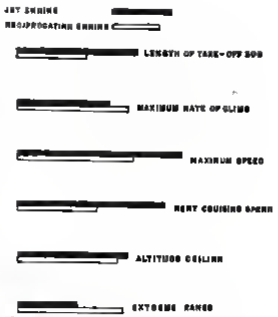


Fig. 13. General performance comparisons for two planes of Fig. 12.

run, rate of climb, and extreme range The jet propelled craft is superior to the conventional power plant job in all particulars except takeoff, climb, and range By using a jet engine of 50 to 70 percent greater thrust than in this example, the takeoff run would be reduced to about the same as the conventional fighter, the climb and ceiling would be greatly increased, and the cruising speed and maximum speed would be increased slightly, all at the expense of a heavier power plant and a further serious reduction in range.

These comparisons are also true for large craft such as transports and bombers, though particularly in the case of the bomber it is even more difficult to achieve really large reductions in drag because of the constant large increments of drag due to armament and avigational devices. Substantial reductions in drag can be effected, but not enough to result in jet versus piston engine fuel rates of the order indicated in Fig. 12.

Turbine-Propeller Applications

The gas turbine geared to a propeller (Fig 7) with typical fuel consumption rates shown in Fig. 8 has the advantages of the jet engine with respect to drag reduction and ease of installation, yet retaining the high propulsive efficiency of the propeller at low speeds. The present limit of usefulness of the geared propeller turbine at high flight speeds is set by the characteristics of available propellers which lose out quite rapidly in efficiency above 500 mph.

Research on propellers is necessary for several reasons, however, and propeller manufacturers are hopeful that the good efficiency range can be extended to considerably higher speeds. Something must also be done to reduce the necessity for large spinner diameters on present propellers to take full advantage of the small diameter gas turbine, and some weight reductions

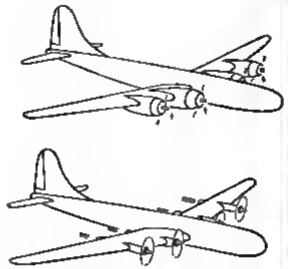


Fig. 14. Appearance comparisons of two large craft, upper with reciprocating engines, and lower with gas turbines geared to propellers. Power plants have equal shaft output ratings at 20,000 ft.

may be possible due to the absence of torsional vibration in the turbine propeller shaft. Estimates of possible propeller weight reductions vary from 0 to 25 percent from present weights. There has been considerable speculation and calculation of the advantages and disadvantages of shrouded propellers; but at the speeds now contemplated, the extra complication does not yet appear profitable.

Principal and immediate advantage of the geared propeller gas turbine is a large reduction in airplane drag. Fig. 14 shows two large planes, one with conventional engines and the other as it would appear with turbines. Over-all power plant performance for the gas turbine with geared propeller is shown in Figs. 15 and 16, which should be contrasted with Figs. 10 and 11 for the piston engine power plant.

Note that the pure thrust power obtained from the turbine exhaust is large enough to approximately offset engine nacelle drag and ordinary propeller losses under normal flight conditions. Therefore as an approximation, the shaft power output of a geared turbine of this type is roughly equivalent to

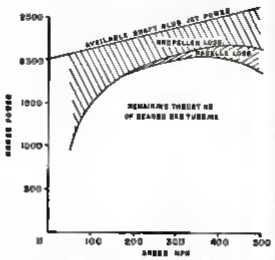


Fig. 15. Typical flight losses estimated for gas turbine engine with geared propeller. Note that jet thrust almost offsets propeller and nacelle losses through large part of speed range shown.

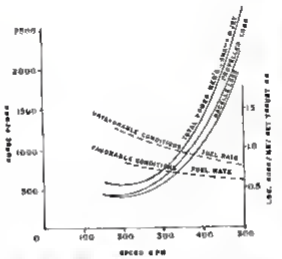


Fig 16. Typical flight losses of the geared gas turbine power plant of Figure 15 when operated on the power required curve of high speed craft at 20,000 ft.

its net thp as a complete power plant under flight conditions Fig 16 should be compared with Fig. 11 for a direct comparison of total power plant losses of conventional engine power plants and geared turbines with propellers

It is possible to make a choice of the division of power outputs of a turbine-propeller unit between jet exhaust thrust and the propeller shaft For example, for a very high speed plane that must still have a good takeoff characteristic, 50 percent of the power might be used in jet thrust and the remainder in the propeller For ordinary applications, however, between 20 and 25 percent of the available energy should remain in the exhaust jet, the turbine shaft recovering the remainder. Thus, for the example chosen here, most of the energy is absorbed by the propeller with excellent over-all power plant performance at low flight speeds, and with fuel economy at high power levels that is quite superior to the conventional power plant.

This type of power plant is equally adaptable to fighters or large planes. The improvement in fuel efficiency with increasing airspeed and power results in somewhat higher cruising speeds than for craft with reciprocating engines. The decrease in available power at higher altitudes makes it necessary to install gas turbine power plants that may have considerably more power at sea level and for low altitude climb than is now considered normal in airplane design. However, this is an advantage rather than a disadvantage; a propeller able to absorb the turbine's shaft output at 20,000 or 30,000 ft can efficiently handle the greatly increased output of the same turbine at sea level, due to the presence of denser air at low altitudes Thus a turbine power plant with a rating equal to that of a supercharged conventional engine at 20,000 ft might have a take-off thrust at sea level 60 percent in excess of the thrust of the conventional engine A much shorter takeoff run

than normal is therefore possible, and rate of climb is greatly superior to the conventional craft

The field of usefulness of the gas turbine with propeller then extends to all craft requiring engines of greater than perhaps 1,000-2,000 hp and designed for speeds up to and in excess of 500 mph

The total thp requirements of a typical large (4-engine) airplane at 20,000 ft are shown in Fig 17 Curve

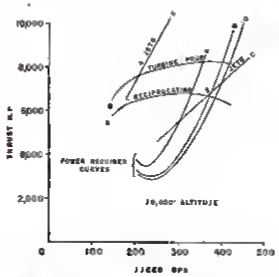


Fig 17 Power-available and power-required curves of large (120,000 lb) plane with four engines. Curves A are for reciprocating engines, B for gas turbines geared to propellers, and C for jet engines

A is for the plane with reciprocating engines and includes all power plant drag losses but does not include propeller efficiency Curve B is for the same plane but with gas turbine engines geared to propellers Curve C is for a jet propelled craft similar in appearance to the turbine-propeller plane but without propellers Gross weight in each instance is assumed to be 120,000 lb and power plant plus fuel weights are held constant.

The conventional engine installation is four engines supercharged to 2,000 hp each at 20,000 ft. In the jet propelled version, four 6,000 lb static thrust engines are used This will give 24,000 lb takeoff thrust—approximately equal to that of the plane with reciprocating engines Once in flight, two of the jet engines will be shut off for cruising under 25,000 ft. and the others will be used for propulsion In the gas turbine-propeller version, four engines are used capable of delivering 2,000 shaft hp each at 20,000 ft. At takeoff, these engines will deliver 3,200 hp each. A propeller designed to absorb 2,000 hp in the low density air of 20,000 ft. can handle 3,800 hp. at sea level with the same level of propulsive efficiency Power availability curves for these power plants are also given in Fig 17 (shown for flight with either two or four jet engines in use). Thus, at takeoff, the three versions appear as in the following table:

Table I—Takeoff Conditions

	Gross Wt (lb.)	Inst. Power Plant Wt. (lb.)	Fuel Wt (lb.)	Takeoff Thrust (lb.)
Convent.	120,000	30,800	40,000	28,000
Turb.-Prop.	120,000	16,200	46,000	44,000
Jet Prop	120,000	8,000	52,800	24,000

Cruising conditions are shown below in Table II and as mentioned before, jet cruising is on four engines at 35,000 ft. and on two engines only at 20,000 ft. Fuel consumption with four jet engines operating is prohibitive for

Table II—Cruise Conditions (20,000 ft.)

	Best Cruis (mph.)	Mi. per lb fuel	Extreme Range (mi.)
Convent	250	0.120	4,800
Turb.-Prop (4 eng.)	300	0.125	5,700
Turb. Prop. (2 eng.)	280	0.143	5,500
Jet Prop (2 eng.)	350	0.050	2,650
Jet Prop (4 eng.-35,000 ft.).	460	0.066	3,500

operations other than at takeoff or very high altitudes Cruising with four gas turbine-propellers in use is tabulated, and also with two turbine propellers in use and two feathered Suitable drag allowance has been made for the feathered propellers

Sensitivity of the gas turbine-propeller to partial load operation is seen in Table II, an 18 percent increase in range being obtained by operating two engines close to full load and maximum efficiency rather than operating four engines at less than half load. This is a fundamental difference that exists between turbines and reciprocating engines, and it makes necessary a careful selection of turbine ratings for any given application if maximum fuel economy is to be gained.

The same conditions are true of jet propulsion engines, and it is profitable to operate close to 80 percent of full rating of the turbines either by shutting down excess power units or going to a sufficiently high altitude to decrease the maximum rated output to a value near the required flight power In the case of jet propulsion, since high speed and high propulsive efficiency go together, very high altitude operation is essential to maximum flight economy

The general characteristics of the three planes described in the tables are compared by the bar charts of Fig 18 Note that the gas turbine-propeller plane is superior to the conventional aircraft on every count except for altitude ceiling, where they are about equal if the reciprocating engines are turbosupercharged Since turbine-propeller fuel economy and installed power plant weights are both superior to those of the conventional engine, the long and short range load-carrying

abilities of the turbine propeller craft are superior to the conventional.

On the other hand, the jet propelled craft has a very light power plant installation and can get off the ground for very short flights with about five tons more payload than the conventional craft, and with about three tons more than the turbine-propeller version. However, jet propulsion requires so much more fuel than other types of

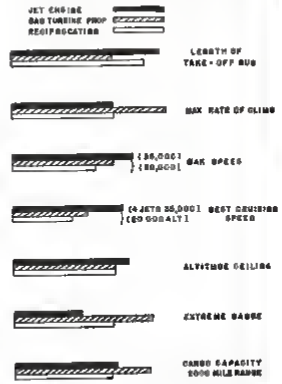


Fig. 18. General comparisons of characteristics of three planes of Fig. 17 and Tables I and II.

power plant, that at about 2,000 mi extreme range, the jet plane loses out to the reciprocating engine and is far behind the geared turbine in payload-carrying ability.

As found in the case of the jet propelled fighter, the jet bomber or cargo plane must be limited to relatively short range, very high speed, and high altitude operations which can stand the expense of high fuel costs, until we have learned more about the aerodynamics of flight at speeds over 500 mph. The gas turbine with geared propeller, however, has immediate applications in all classes of service where requirements are much above 1,000 hp at usual flight altitudes, and it should be ready for use when aircraft designs require 10,000 or more hp. in a single power plant unit.

Australian Aviation

(*Continued from page* 109)

ers are opposing the move, contending that the price is too low in view of the remarkable record of the company in dividends—up to 40 percent a year was paid in the peak days of the gold trade before the war. If the merger is completed, Australian National would be the largest organization in the South

Pacific area It is owned by British and Australian shipping interests, and none of the stock is held publicly

A new company, as yet unnamed and about which no details have been given, is investigating the possibilities of inaugurating a lighter-than-air service between Australia and America

Recent reports indicate that the Chinese government intends to establish service to Australia via the Dutch East Indies Although no official intimation has been given, it is thought in semi-official Australian circles that the Australian government will sponsor a similar service, in view of the large trade anticipated between the two countries

In addition to the air transportation plans, the government has stipulated its intention of continuing the aircraft manufacturing industry which has been established during the war It is planned to swing this organization to civil aviation needs when war production ceases.

Present plans include manufacture of Rolls-Royce engines to be fitted for transport craft based on the Lancaster designs The Commonwealth Aircraft Corp, in which the government has a very substantial shareholding, will be the instrument for implementation of this scheme It is also proposed to produce a small cabin craft suitable for the private owner or taxi operator, but no information is available on the design or expected performance

DeHavilland has not yet made any official announcement of its postwar plans, but the company has a very active branch in Australia, now producing Mosquito bombers, and this organization is almost certain to play a leading part in aircraft production when the time comes

Opinion is unanimous that commercial aviation has a very bright future in Australia, but it is feared that nationalization would, to a large extent, stultify the expansion plans reported here. Few people interested in the transport and manufacturing phases of the industry can visualize a government monopoly making progress equal to that which private airline operators have already indicated they are capable of achieving

Traffic Estimates

(*Continued from page 175*)

of hours for each type of transportation is increased by 5 percent—the generally accepted estimate for population increase over this period. The number of annual travel hours per person is thus unchanged The hours must then be redistributed to show the shift towards air travel.

Air travel is divided into two classes —airline and personal. The commercial airline will probably grow very rapidly because reconversion problems will be comparatively simple. There will be little trouble getting personnel or equipment. In addition, most of the technical difficulties likely to be faced, including that of dependability in bad weather, have already been completely or partially solved during the war.

Private flying, on the other hand, will develop much more slowly. One of the most enthusiastic groups, the returning soldiers, will be among those who are least able to afford flying. In addition, rapid growth will come only when there is a high utility value. This will take time since it will require the use of numerous conveniently placed airports—many of which haven't even been planned yet. The estimate of the number of hours transferred to personal flying is, therefore, kept very conservative.

The percentage of hours diverted to air travel from each of the other means of transportation will vary considerably. The auto, for instance, will not be replaced by the airplane as the horse and carriage was replaced by the auto, for the situation is not quite comparable. The auto did everything the horse could do and did it faster, better, and more comfortably for trips of any length.

The airplane's advantages, however, are limited to trips of at least a few miles. It offers no competition for the man who drives half a mile to work or for his wife who drives around the corner to the grocery store. The plane will cut into the auto's mileage but the auto will continue to remain a necessary complement to it. A conservative estimate of the number of automobile hours lost is 1 percent. Of this, .9 percent will go to the personal plane and only 1 percent to the airlines.

Rail passenger traffic presents a much more favorable field. The railroads have already eliminated all very short runs by spacing their stations a few miles apart. They aren't as widely separated as airports will be, but it is a step in the same direction. Air travel first affects Pullman traffic, partly because the latter generally involves longer trips and thus there is an invitation to greater savings in time, and partly because the rate comparison is so much more favorable (especially when the average saving of almost 20 percent in mileage is considered). It is assumed that the railroads will lose 20 percent of coach traffic and 45 percent of Pullman traffic with all but 1 percent of the Pullman business going to the commercial airlines. These percentages are very conservative since on some routes the airlines have

already taken over 20 percent of passenger traffic.

The effect on other types of transportation will be negligible. The intercity bus holds most of its business because of the extremely low rates with which the airlines probably will be unable to compete, at least for some time to come. Commutation, electric railways, and intracity buses involve distances that are too small for profitable air service.

This redistribution of hours, as shown in Table III, results in figures of 226 and 201 million passenger hours, respectively, for airline and personal plane operations. Again using the estimated average velocities, the distance figures come to 31.6 billion passenger miles for commercial airlines and 21.1 for private planes.

The general trend in travel, as shown in Table II, indicates that the hours spent annually by the average person remain constant, but the speed and mileage will more than double during the 25-yr. period from 1925 to 1950.

The problem now comes to its final stage—determination of the number of planes necessary to handle the predicted traffic. This calls for dividing the total number of passenger hours that will be traveled by the number that the average plane will account for.

We hear more and more of the giant airliners of the future, and orders have already been placed for many in the 50-60 passenger classification. But this isn't the whole story. There will be far more smaller planes used on short runs and for feederlines. When we consider this, and the fact that most planes rarely operate at capacity loads (except under wartime conditions), 30 passengers per plane is probably a fairly high average. Since the more passengers the plane carries, the fewer planes are needed, this high average will result in a conservative final answer.

The number of hours flown annually per plane is assumed to be 3,500. This is 40 percent of the total number of hours in a year and just a bit higher than the prewar airline figure. The average plane's annual capacity is then put at 105,000 passenger hours, as shown in Table IV, and since 226 million passenger hours are to be handled, about 2,150 planes would be required.

The number of personal planes needed can be calculated similarly, but in this case the average number of people per plane is assumed to be 2 (the average for automobiles is only about 2½), and the number of hours flown is gaged at 300 per year. Each plane then would handle 600 passenger hours, and 335,000 planes would be required.

These figures are based on passengers only If cargo is also considered, the number of airline planes would be increased considerably

The final estimates may seem extremely high; yet when they are compared with other predictions, it will be found not only that they aren't fantastic but that, on the contrary, they are based on more conservative assumptions than those often used They differ only in that here an attempt has been made to accurately estimate the over-all increase in travel mileage Results show that this is a very important factor and one which would very probably have been underestimated if its solution had been attempted by any more arbitrary method

UAL Pres W A Patterson assumed, in Feb 1943, that the airlines would get the following postwar business:

- ⅔ of Pullman business
- ¼ of rail coach business
- ⅛ of interstate bus business
- ¼ of railway express business
- ¼ of parcel post business
- ⅓ of LCL railroad freight business

This was to be handled by—

- 3,000 20-passenger planes
- 1,500 50-passenger planes
- 750 100-passenger planes

That gives a total of 5,250 planes averaging 40 passengers each This high value, however, is partly due to Mr Patterson's inclusion of mail, express, and some freight, in addition to passengers It also appears that by "postwar" he means not 1948 or 1950 but some time beyond that, since it will be several years before the airlines can get 75- or 100-passenger planes

Pres Croll Hunter, of Northwest Airlines, has predicted a need for 25,000 to 30,000 cargo planes

It is interesting to note that these increases are not based on any increase in total travel mileage but only on diversion of business from other means of transportation They assume rates of approximately 10c per ton-mile of cargo and 3c per mile for passengers (the 1943 rates averaged 58 and 5 53c), and also take into account the saving of almost 20 percent in mileage that the airline route usually shows over the rail route

The estimate of 335,000 private planes is slightly higher than a CAA measure of 300,000

The estimated 335,000 personal planes is the potential number for 1950. It might be cut down a little by limitations in production capacity, but not too much It wasn't long ago that predictions of 50,000 planes a year were laughed at. That figure has nearly been doubled, and not with simple, easy to build, personal planes Included in

this production performance were thousands of the most complex fighters and bombers ever conceived

It is becoming increasingly evident that, in the postwar period, aircraft will still be a large and influential industry For the nation's economic prosperity as well as its military security it is necessary that the industry be organized soundly and efficiently This means that airlines, aircraft manufacturers, airport designers, and airport operators must immediately look to the future and start planning accordingly The dynamic nature of aviation development makes it important that the planning be flexible and expandable

However, certain estimates of activity are necessary in even the most flexible plan, and it is felt that the method discussed here will help in estimating, somewhat more rationally the levels of such future operations This type of careful planning will aid in preventing, on the one hand, failure to develop the full potentialities of aviation and, on the other hand, overexpansion with its accompanying insolvency and chaos

Blackburn Airliner

(*Continued from page* 164)

figures are based on daytime seating arrangements For a 4,375 mi range, 72 passengers, with sleeper accommodations, and 2,980 lb of freight could be carried, or with daytime seating, 85 passengers and 3,450 lb of freight.

Since operations would be planned at a 15,000-ft. altitude, all crew, passenger, and freight space would be pressurized, with atmospheric conditions equal to those at 8,000 ft. To permit this, the craft's hull is designed with an approximately circular cross section extending the entire length, and the planing section would be built onto this form.

The pressurized section extends from the bow to aft of the galley, which is at the rear of the passenger or freight compartments The space between the upper fuselage and planing bottom would be divided into water tight compartments which could maintain the airplane's flotation even with two adjacent compartments flooded.

Construction would be all metal, mostly aluminum alloy for frame and skin covering, and steel for highly stressed parts The tail calls for considerable dihedral in order to increase clearance from the water during takeoffs. Wing floats could either be fixed or retractable Thermal de-icing would be used for propellers and leading edges of wings and tail The entire fuel supply would be carried in the

proposed flying boat's cantilever wings.

Type of engines or horsepower is not given, but it appears from the photographs and three-view drawings that a combination turbine-propeller arrangement is being considered. The propellers would be of the six-blade contra-rotating type.

Specifications and Data

Span	202 ft.
Length	148 ft.
Wing area	5 000 sq. ft.
Top speed (sea level)	307 mph
Absolute ceiling	20 000 ft
Cruising altitude	15 000 ft.
Initial rate of climb	940 ft./min.
Maximum gross weight	310 000 lb

Cruising Performance I

Still air range	2 500 mi
Mean Cruising speed	269 mph.
Payload*	85 day pass. plus 57 710 lb. freight and mail; 120 day pass. plus 44,960-lb.; 160 day pass. plus 30,4604 lb.; all freight 90 980-lb

Cruising Performance II

Still air range	4,375 mi
Mean cruising speed	280 mph
Payload*	85 day pass. plus 3,450-lb. freight and mail, 45 sleeper pass. plus 15,125-lb.; 72 sleeper pass. plus 2 980-lb.

*Payloads are based on passenger wt. of 180-lb. plus 56-lb. of baggage per passenger.

Overhaul Business

(*Continued from page 159*)

should provide the shop superintendent with information he can use quickly without being an economic analyst.

Costs of this useful nature sometimes show up startling facts. One particular job may be carrying the rest of the shop, or the shop may actually be losing money and drawing from the sales division. The latter case, of course, would reflect some badly jumbled accounting in the front office.

Direct labor and material should be considered in relation to other shop costs before any final price is set on a job. Direct-labor plus direct-material are added to a pro-rated share of factory expense to give the so-called prime cost. Further additions are general-expense, selling expense, and profit; the sum of all should be the cost to the customer.

Connection Techniques

(*Continued from page 137*)

adopted zinc plated aluminum Hylugs as standard.

Cold Flow Studied

As previously mentioned, aluminum may continue to flow under constantly applied pressure unless that pressure is exerted over a sufficiently large area to carry the load. In electrical connections, this is known as "relaxation". As the metal in the connection relaxes, the contact pressure decreases, and consequently the electrical resistance of the connection increases.

To determine the effect of cold flow on aluminum connections, tests were performed over a period of six months. Two identical jumper assemblies, as shown in Fig. 6, were prepared using No. 2/0 aluminum aircraft cable, one being loaded with 100-lb. At regular intervals throughout the test period, measurements of resistance between points (A) and (B) were taken. tension on the loaded jumper being released when measurements were made. Fig. 7 shows how electrical resistance changed with passage of time.

Note that both loaded and unloaded samples exhibited a slight increase in resistance for a period of about three months, the loaded sample showing a slightly greater increase. However, after this period the curves for both samples are practically parallel, and other than minor variations show little change. Thus it can be seen that cold flow of the connection, with or without tension applied, has only a minor deteriorating effect.

Only the most difficult problems connecting connections of aluminum aircraft cable have been discussed here for it has been found that when these problems are solved, minor performance difficulties are automatically overcome.

Summarizing, the following precautions should be observed to obtain good electrical connections with aluminum aircraft cable:

(1) Skin cable end carefully, to avoid nicking of strands. Aluminum strands are very easily damaged and much more care must be used when skinning than is required with copper cable.

(2) Do not splay or misshape strands. Cable end should be substantially in its original shape.

(3) Do not remove zinc-petrolatum compound from connector barrel.

(4) Insert bared cable end into connector barrel. Hold inspection hole in back end of barrel closed (with finger) to force zinc-petrolatum compound between cable strands.

(5) Indent connector onto cable end, making certain that correct dies for use with aluminum cable are used.

Review of Patents

(*Continued from page 202*)

angle with respect to fuselage sides.—2,370,801 filed May 14, '41; pat. Mar. 6, '45; A. J. Klose, assignor (by mesne assignments) to Consolidated Vultee Aircraft Corp.

Ice Preventer utilizes engine exhaust to heat leading edges of wings, tail group, and fuselage by incorporating thermostat to operate motor acting to open valves to admit hot gases from collector ring to heating pipes.—2,371,269, filed Dec. 10, '42, pat. Mar. 13, '45; L. S. Seaman.

Automatic Control System is designed to cause turns to be automatically made at correct angle of bank. It employs in combination, adjustable means for determining rate of turn and means for determining attitude or angle of bank, manual control for simultaneously presetting both said means and auxiliary control for correcting any error in matching between preset rate of turn and angle of bank.—2,371,284, filed Dec. 26, '42, pat. Mar. 13, '45; A. P. Glenny, assignor to Sperry Gyroscope Co., Ltd.

Ice Detector is intended to utilize light rays transmitted parallel with and closely adjacent to leading edge of wing to electrical resistance element or photo cell current through which is affected by freezing of water film normally caused by rain, to cause actuation of indicator or of mechanism controlling deicing device.—2,371,286, filed June 13, '43, pat. Mar. 13, '45; A. S. Patterson.

Landing System incorporates pair of transmitting stations aligned with and equally spaced from runway, modulating signal having wave length twice distance between stations and having predetermined phase relation, means for modulating carrier currents differing in station frequency, dual channel radio receiver in aircraft for receiving signals, screen for indicating relative longitudinal position of runways as abscissa, and means responsive to altimeter for indicating attitude of craft as ordinates.—2,371,372, filed June 26, '41, pat. Mar. 30, '45; E. H. J. Phillips.

Aerodynamic Means for longitudinal control and stability intended to provide greater tail force for given angle of pitch is accomplished with hollow stabilizing plane slotted in upper and lower surfaces, blower to produce inward flow through slots, valve to direct major flow through either slot, and pilot's steering means and wind sensitive auxiliary vane connected to valve vane serving to direct flow to slots differentially in accordance with wind direction and to transmit force to steering means.—2,372,301, filed Nov. 13, '30, pat. Mar. 27, '45; E. A. Stalker, assignor to Dow Chemical Co.

Landing Wheel Rotation Means consist of series of enclosed vanes against which high-velocity air impinges to spin wheel prior to ground engagement during landing.—2,372,207, filed Sept. 5, '42, pat. Mar. 27, '45; J. F. Kendrick.

Wing Construction relates to airfoil sections with upper and lower cambers capable of being flexed under control of pilot to varying thickness of wing contours of cambers remaining substantially unchanged.—2,372,447, filed Nov. 13, '43, pat. Mar. 27, '45; L. E. Peters.

Prevention of Ice Formation is accomplished by anti-freeze liquid conducted through porous metal adjacent to exposed aircraft surface.—2,372,991, filed Nov. 17, '42, pat. Mar. 27, '45; W. D. Jones, assignor to Sheepbridge Stokes Centrifugal Castings Co., Ltd.

Autopilot designed for landings in fog is applied to automatic gyro-pilot of hydropneumatic type and provides complete system for automatic flight to maintain craft on predetermined compass course, stabilizing and flying it towards predetermined radio-sending station or along radio beam.—2,372,184, filed July 10, '43, pat. Mar. 27, '45; R. G. Carlson, assignor to Sperry Gyroscope Co.

Aircraft Course Recorder consists of platform for map mounting and means for causing movement of map at rate proportional to plane's speed and in conformity with variations in compass bearing.—2,368,925, filed May 28, '43, pat. Feb. 20, '45; I. Shemuh.

Book Reviews

(*Continued from page 202*)

structor rating are examined, i.e., topics of navigation, meteorology, aircraft and aircraft power plants. Glossary contains definition of terms used in book.

EMPLOYEE COUNSELING, by Nathaniel Cantor. 167 pages, text, bibliography. $2.00.

Study of the counseling movement in industry, presenting a social and psychological theory underlying employee coun-

selling and outlining the training skills and procedures needed by the personnel consultant in reaching causes of employee dissatisfaction. Aims at providing data and information needed to set up a workable program in either the small factory or extensive industrial plant.

THE FUTURE OF INDUSTRIAL RESEARCH. Standard Oil Development Co., New York City. 173 pages. Text.

Discussion by various industrial experts and spokesmen of the future of industrial research in a number of scientific fields. Viewpoints are presented through the eyes of a physicist, chemist, businessman, etc.

FIGHTERS UP, by Eric Friedheim and Samuel W. Taylor. Edited by Arthur Gordon. Macrae Smith Co., Philadelphia. 275 pages, text, photos. $2.50.

Described as "complete story of the pilots and planes comprising the Eighth and Ninth Air Forces Fighter Commands operating in the European theater," this book opens with the establishment of bases in England and carries on through participation in the D-Day invasion of Europe and down to Jan. 1945.

STRESS RELIEF OF WELDMENTS FOR MACHINING STABILITY, by J. R. Stitt. Ohio State University Press, Columbus, Ohio. 47 pages, text, graphs, appendix. $.50.

Study of four low-alloy steels as stress relieved at a range of temperatures from 800 deg. F. to 1,400 deg. F., using a constant time of 8 hr.

ASTRONOMICAL NAVIGATION WITHOUT MATHEMATICS, by A. L. Mayville. The Macmillan Co., New York City. 25 pages, text, graphs. $.65.

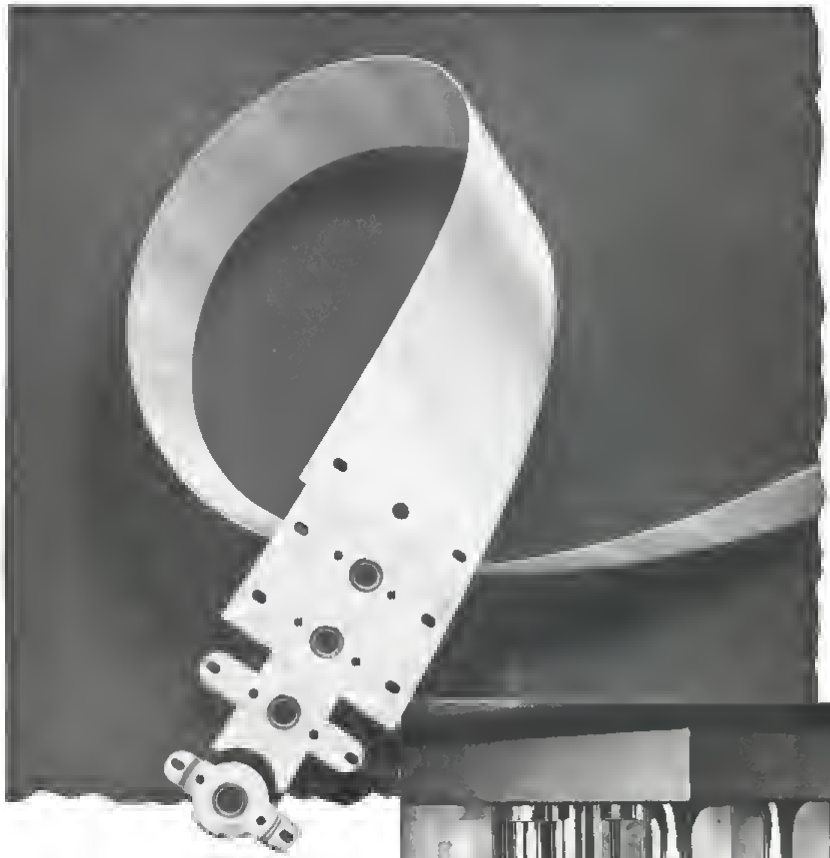
Offered here is a method of avigation featuring reduction of calculations.

JANE'S ALL THE WORLD'S AIRCRAFT 1943-44. Compiled and Edited by Leonard Bridgman. The Macmillan Co., New York City. Text, photos, drawings. $15.00.

This is the latest in Jane's annual series of comprehensive reviews of modern aircraft and of engines their service and progress achieved both in military and civil fields. Continuing its top-shelf ranking as a reference work, the new edition contains the usual thorough descriptive and illustrative treatment of craft, sectionalized by nations, and in addition there is a special feature article, "The Waning of German Air Power."

CONFERENCE LEADERSHIP IN BUSINESS AND INDUSTRY, by Earle S. Hannaford. McGraw-Hill Book Co., New York City. 289 pages, text, graphs, index. $3.00.

Outlines step-by-step procedure for conducting day-to-day business conferences and formal conferences, including procedures for preparing conference material and guiding and shaping discussions, and also offering suggested programs for training and development in conference leadership.



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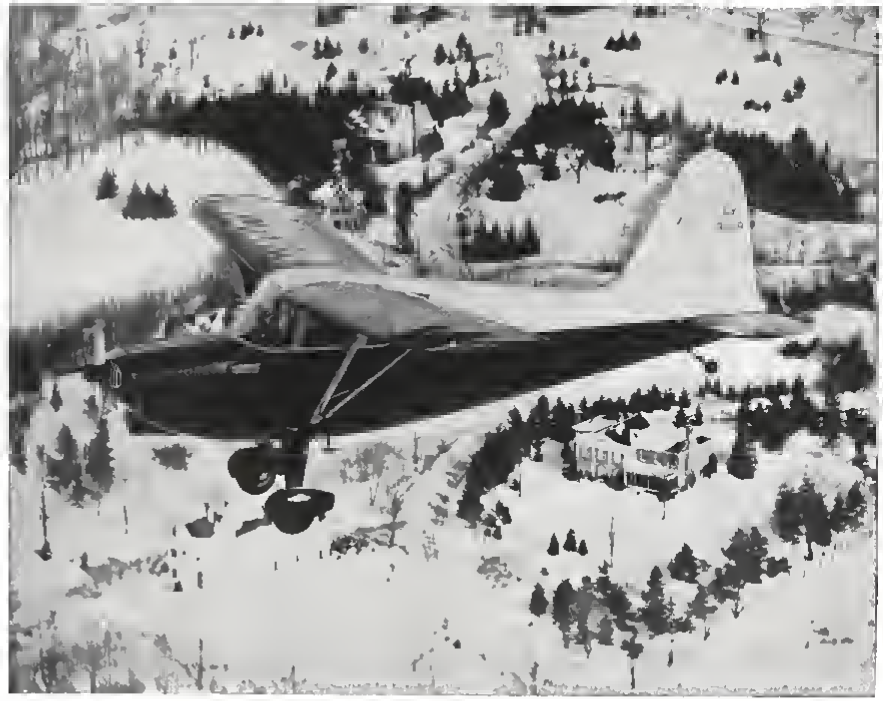

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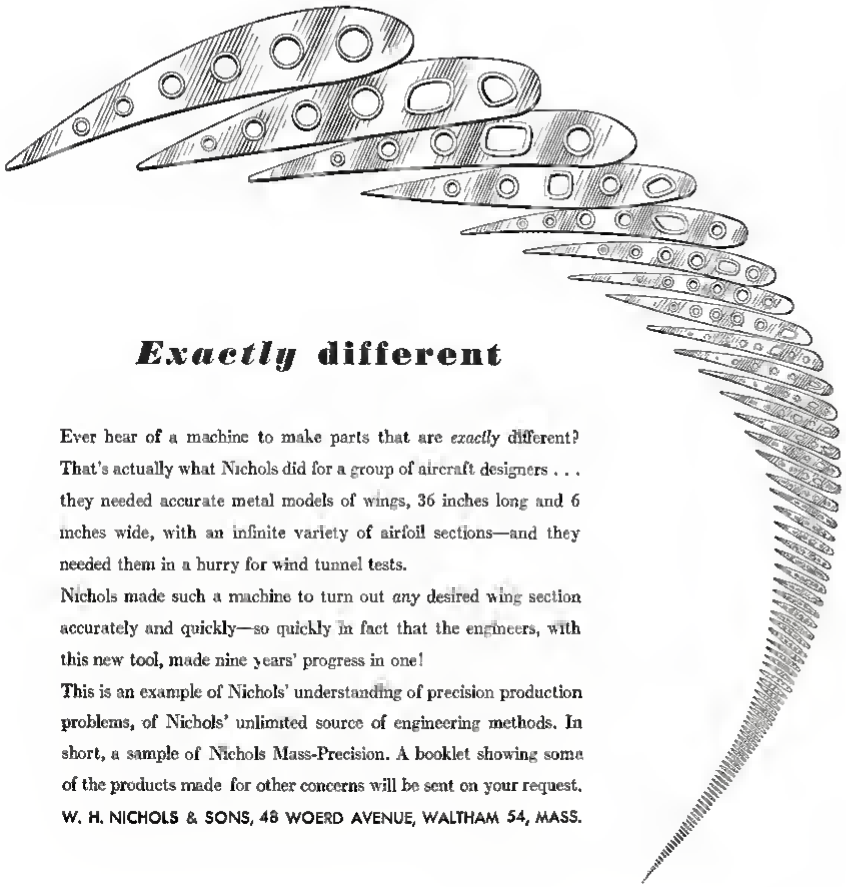

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This transport gets EXTRA STAMINA from seamless tubing

SHELBY Seamless Tubing construction of the Constellation's main landing gear

YOU'RE looking at America's largest, fastest, most powerful cargo or transport plane. This giant new Lockheed Constellation can cross the continent non-stop in less than 9 hours, fly to Honolulu in 12. Powered by four 2,200 horsepower engines, its cruising speed at 65% power is over 300 miles an hour. It can fly, climb and land on three or even two of its four engines. It can carry 64 passengers and a crew of six in a cabin that is pressurized for flight 20,000 or more feet—"above the weather."

Like many other super ships of the world's greatest air fleet, the Constellation has attained maximum strength and minimum weight through the extensive use of Seamless Steel Tubing. No other form of construction has a higher strength-weight ratio for engine mounts, landing gear, wing spars, longerons, fuselage struts, and tail assembly.

All SHELBY Seamless Tubes are made to exacting government specifications and are available in a complete range of sizes and shapes in the current range of alloys.

SHELBY SEAMLESS *Aircraft Tubing*

WALLS WITHOUT WELDS

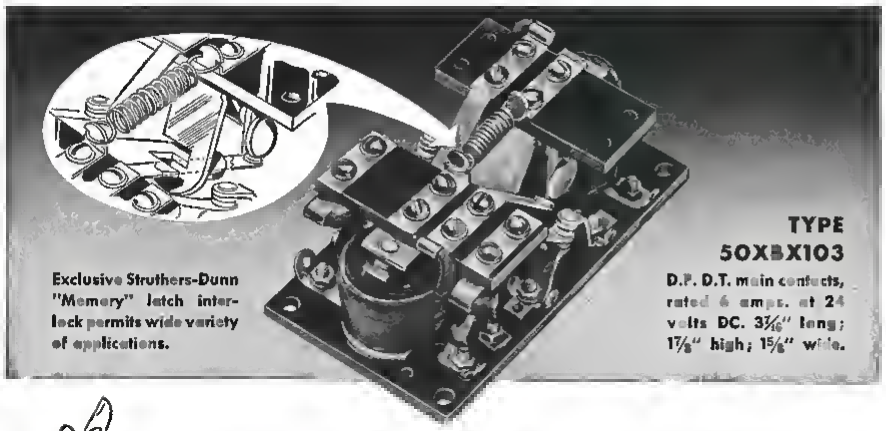
NATIONAL TUBE COMPANY

PITTSBURGH, PA.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
United States Steel Export Company, New York

NATIONAL TUBE COMPANY — USS STEEL — UNITED STATES STEEL

UNITED STATES STEEL



Exclusive Struthers-Dunn "Memory" latch interlock permits wide variety of applications.

TYPE 50XBX103

D.P. D.T. main contacts, rated 6 amps. at 24 volts DC. 3 3/16" long; 1 7/8" high; 1 5/8" wide.

A New Struthers-Dunn "MEMORY" RELAY SERIES

Simplified Interlock—Symmetrical Design

Sturdily constructed to aviation specifications, and of immensely simplified design, Series 50XBX 2-coil Relays are an important addition to the well-known line of Struthers-Dunn "Memory" types. A new style positive interlock between the two symmetrical operating elements represents latch-in relay construction in its simplest, most dependable form. This latch requires no extraneous parts other than integral extensions of the sturdy coil "armatures" themselves. It operates positively from a momentary impulse and a minimum of power. Application of power to one coil latches the contacts into one position. Power then applied to the other coil throws the contacts into a latched-in second position. A third "unlatched" position, valuable for certain applications, can be obtained by energizing both coils simultaneously.

The 50XBX design makes it easy to obtain make-before-break, or break-before-make contact combinations. Contacts do not interrupt the coil circuit until the "throw" is entirely completed and contacts are locked in the new position.

Struthers-Dunn Memory Relays of this general type are produced in ratings from 6 to 200 amperes or more, and with practically any desired contact arrangement. Standard types provide for two auxiliary contacts, one in each coil circuit. The use of auxiliary contacts makes it possible to obtain operation over an extremely wide range of voltages, a-c or d-c.

STRUTHERS-DUNN, INC., 1321 Arch Street, Philadelphia 7, Pa.

STRUTHERS-DUNN

5,288 RELAY TYPES

DISTRICT ENGINEERING OFFICES: ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DENVER • DETROIT • HARTFORD INDIANAPOLIS • LOS ANGELES • MINNEAPOLIS • MONTREAL • NEW YORK • PITTSBURGH • ST LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO • WASHINGTON

JACK, SENIOR, learned to fly in the last war. When this one came, he and 80,000 others like him joined to form the Civil Air Patrol. They pitched in and did a whale of a job . . . at a time when there just wasn't any one else to do what they did.

A lot of them had learned to rely on their Lycoming Engines during the peacetime years and they learned again how right they were under the emergency-flying stress of war.

JACK, JUNIOR, is in the Air Corps now. *He learned to rely on Lycoming, too . . . and he learned it right in the plane he trained in!* . . . Little Jackie, of course, was making airplane engine noises before he could talk! The phrase "YOU CAN RELY ON LYCOMING" is more than just words. *It's a flying fact!* You can go back many years to its start. You can look a long way ahead to its future.

Fathers and Sons know it today...

YOU CAN RELY ON LYCOMING!

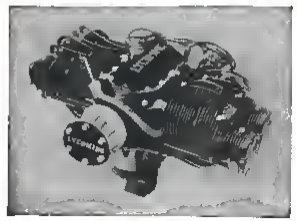
LYCOMING, MODEL O-145
DEVELOPING 65 H.P. AT 2550 RPM

LYCOMING

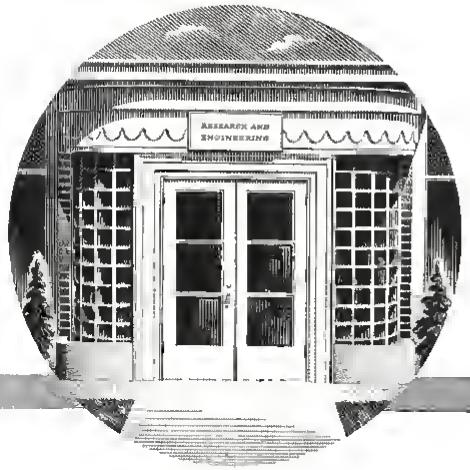
AIRCRAFT ENGINES . . . 55-300 H. P.

Avco

Lycoming Division
The Aviation Corporation
Dept. D-9, Williamsport, Pa.



POWERED BY LYCOMING—THE ENGINE WITH A PROVEN PAST AND A SURE FUTURE



Entrance to a broader use of chromium

Recent years have seen many uses of chromium developed . . . particularly in the field of electro-deposited, hard chromium. Van der Horst Corporation has taken a leading part in these developments, and now offers its experience and technical facilities to manufacturers who look forward to greater use of the advantages that hard chrome can give their products, and whose production in quantity and quality will justify their own production facilities.

The technique of applying decorative chromium has long been known. The more difficult application of hard chrome for critical bearing surfaces is a new technique which has been successfully solved by Van der Horst.

Van der Horst now announces a comprehensive service to individual manufacturers and government agencies for the engineering, designing and installing of complete facilities for heavy deposit, hard chrome plating. This service may include:

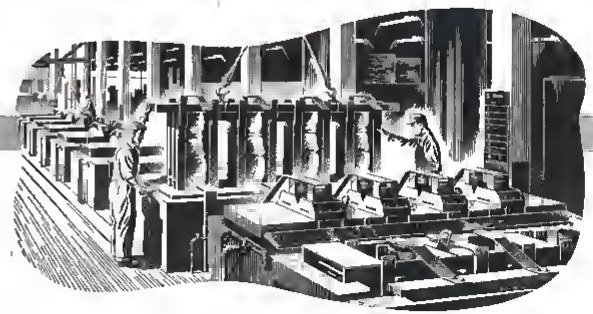
- *Thorough research on the manufacturer's production problem and engineering recommendations for its solution.*
- *Complete plans for layout of plant and equipment to do an efficient production job.*
- *Supplying and installing the production equipment.*
- *Instruction of operating personnel in the technique of production and control.*
- *Advisory guidance on production problems which may arise after the plant has been put into operation.*

Van der Horst engineers are experienced in both types of heavy, hard chroma plating: (1) hard dense chrome, used on bearing surfaces to resist wear . . . even in such difficult applications as the bores of gun barrels, and (2) hard porous chromium, as used on the cylinders and liners, or rings, of internal combustion engines, compressors and pumps, where lubrication is imperative.

License agreements will be made with responsible manufacturers under the basic Van der Horst patents, No. 2,048,578 and No. 2,314,604 for the application of porous chromium . . . no other licenses are required.

In this one organization of technicians and engineers, seasoned by extensive manufacturing experience in the three Van der Horst plants, manufacturers will find a complete service for establishing the production of heavy deposit, hard chrome plating . . . and an undivided responsibility from the conception of the idea, clear through to the plant in operation.

VAN DER HORST CORPORATION OF AMERICA • OLEAN, NEW YORK • CLEVELAND 11, OHIO



The plane of tomorrow is already designed! It's the Consolidated 204 passenger cruiser for Pan American World Airways.

Ten Years Ago The Future Began...

View of one of the lounges in Consolidated Vultee's Model 37, shows modern appointments by Henry Dreyfuss, consultant to Consolidated Vultee.

Ten years ago, "U.S." Koylon Foam was born—and it ushered in a preview of comfort to come. Here is a cushioning made of buoyant latex cells embracing pure, soft air. Koylon fairly *breathes* comfort—and cleanliness, too. It's dust free, odor free and moisture free—self-cleaning. Because Koylon is a single, well-fashioned unit—without troublesome parts—it keeps its shape longer and there are no parts which need repair, replacement or renovation.

Naturally, airmen were quick to adapt this last word in passenger comfort and maintenance economy. But Koylon's prewar service in planes was only a preview of what Koylon can do for you *after* the war.

Comfort Engineered

"U.S." Koylon FOAM

REG. U.S. PAT. OFF.

MISHAWAKA, INDIANA

Serving Through Science

UNITED STATES RUBBER COMPANY

Precision Workmanship + Engineering Know-How =CONTACT PERFORMANCE

THE constant factor in this equation is Mallory—known as Contact Headquarters by manufacturers of relays, industrial controls, business machines, domestic appliances, circuit breakers and other electrical and electronic equipment.

Precision workmanship at Mallory results from the experience which skilled men and women have gained in working with precious metals and special alloys. For instance, depending on the method most suitable for a specific assembly, they can torch, furnace, induction or resistance braze, silver solder, spot projection or flash weld, spin, rivet or stake contacts to supporting members.

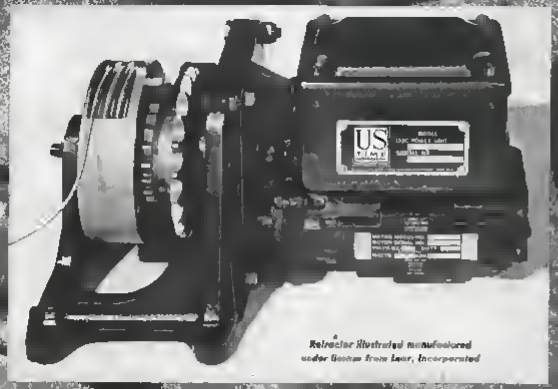
Mallory engineers and metallurgists have 22 years of accumulated "know-how" in designing contacts and contact assemblies and in developing special materials such as Elkonium* and Elkonite*. They have created more than 5000 designs for individual contacts and complete assemblies.

Before your electrical or electronic equipment designs are blueprinted, consult Mallory engineers about contacts. Facilities are available for big production or small orders covering contact assemblies, individual contacts, or contacts joined to studs, springs, arms or brackets furnished by you.

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

*Reg. U. S. Pat. Off. for electric contacting elements.

MUSCLE OF THE *Hellcats'* CLAWS



Relaclor Illustrated manufactured under license from Leer, Incorporated

A Hellcat must land on the flight deck of its carrier with the agility of a leaping panther.

Its "claw" . . . the retractable tail hook . . . must take hold as fast and as reliably as the claws of a panther when it leaps to the limb of a tree.

This little actuator is the "muscle" that makes the Hellcat's tail hook shoot out *instantly* at the flick of a switch . . . The hook grabs a retarding cable which flexibly brings the speeding Hellcat to a stop.

This miniature power-plant is one of very many U. S. Time precision products used in most of our planes, warships and munitions.

World's largest peacetime watchmakers . . . largest precision instrument makers in our industry . . . U. S. Time will soon be ready to mass-produce precision products at low prices for postwar planes. Bring us your problems.

US TIME

The United States Time Corporation

The United States Time Corporation, Sales Headquarters,
Rockefeller Center, 630 Fifth Avenue, New York 20, N. Y.

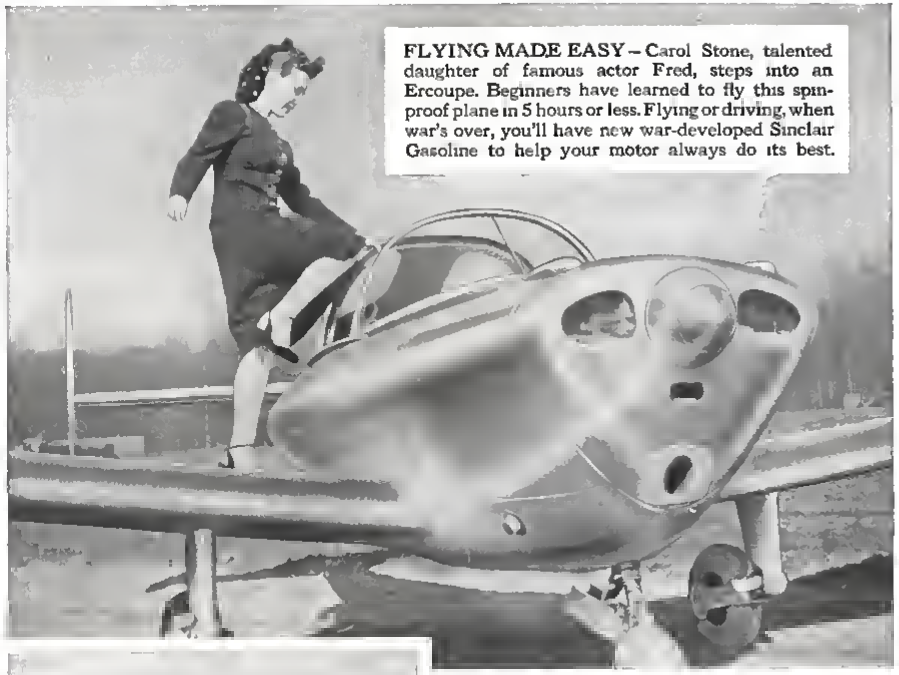
"The Creative Mind and Aviation Research"

by R. E. GILLMOR, President, Sperry Gyroscope Company, Inc.

"THE CREATIVE MIND *of man gives him supernatural powers—not only to further his own evolution, but to adapt the techniques of other creatures to his own use.*

"Engineers, for instance, are now conducting research into the gyroscopic automatic pilot of the Diptera, or two winged insects—two tiny alternating gyroscopes perfectly designed for maximum momentum with minimum weight; and a unique control system for automatically executing the orders of the nervous system. And, although man may never be able to keep within nature's specifications for space and weight, some day we can hope he will catch up with her in matters of gyroscopic design and function.

"But, while science is catching up with nature, all sorts of by-products will continue to emerge from research like this: devices that will automatically keep small private planes on their courses in all kinds of weather; devices that will compensate for treacherous air currents when helicopters land in backyards or on roof tops; pilotless cargo planes; 'trains' of cargo ships controlled by a single lead plane. Man's creative mind, through research, has hardly begun to probe the possibilities of speed and safety in flight."



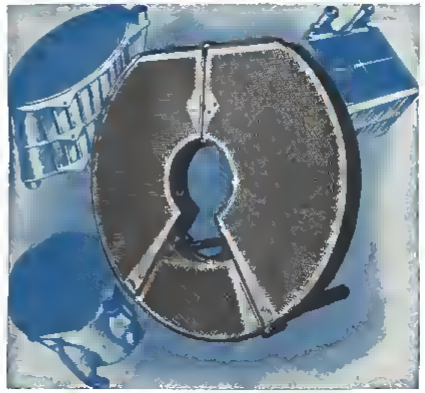
FLYING MADE EASY – Carol Stone, talented daughter of famous actor Fred, steps into an Ercoupe. Beginners have learned to fly this spin-proof plane in 5 hours or less. Flying or driving, when war's over, you'll have new war-developed Sinclair Gasoline to help your motor always do its best.

LIFE LINE TO BATTLE FRONTS –Liberty Ships like this are carrying vital supplies to war zones the world over. Hundreds of these ships are efficiently operated with Sinclair Marine Lubricants.

SAVE *YOUR* CAR from the junk yard. Thousands of worn-out cars are junked daily. Proper lubrication saves wear – helps save cars. See your Sinclair Dealer regularly.

SINCLAIR AVIATION OILS

FOR FULL INFORMATION OR LUBRICATION COUNSEL WRITE SINCLAIR REFINING COMPANY, 630 FIFTH AVENUE, NEW YORK 20, N. Y.



HOW ALUMINUM BRAZING SIMPLIFIES ODD SHAPES

Until recently heat transfer units have been complicated by special reinforcements to give them strength in unusual shapes. At high temperatures the soft solder, which bonds copper tubes to their shells and to each other, could not stand the severe stresses set up by pressure, vibration and shear in *unusual* shapes, unless other weight-increasing supports were added.

ALUMINUM BRAZING CHANGED ALL THAT

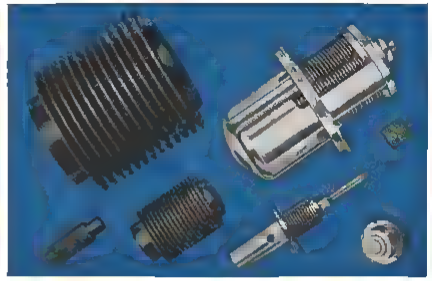
Discovery of a way to braze thin-walled aluminum tubes to aluminum header plates and shells made simply constructed odd shapes possible, for three reasons:

1. Aluminum alloy bonding material defies temperatures, pressures and strains several times higher than soft solder can stand.
2. Heat-treatable aluminum alloy tubes, header plates and shells stand temperatures and pressures that cause copper to anneal and weaken.
3. Aluminum's weight being ½ that of copper affords other obvious advantages to designers of products incorporating heat transfer units.

That's why USAAF designers were quick to take advantage of Clifford's discovery and put Feather-Weights to use in a number of their aircraft models.

POSTWAR PLANNING

Now war orders occupy 100% of Clifford's production . . but inquiries and suggestions about postwar applications of all-aluminum heat-transfer units to automotive heating, cooling and ventilating fields are welcomed. *Clifford Feather-Weights . . . Seem ½ the weight . . . same size and shape.* Clifford Manufacturing Co., 561E First Street, Boston 27, Mass.



IN HYDRAULICALLY-FORMED BELLOWS

the metal has to be right

Metallic bellows can be made four ways:

1. Built up from a number of sections.
2. Mechanically spun from a welded tube.
3. Mechanically spun from a seamless tube.
4. Hydraulically formed from a seamless tube.

The first and second are as strong as their metal and joints; the third as its tool-scratched metal; the fourth as its metal only.

In hydraulically forming a bellows, no spinning tool touches its surface. It's made by forming the paper-thin walls of a metal tube between the plates of a collapsible die by means of internal hydraulic pressure. And since that pressure is much higher than any pressures it will meet in service, any bellows that survive the forming process must be metallurgically sound.

Therefore, to make hydraulic forming practical the metal from which the tube is made must be free from slag and scale inclusions . . . and the tube must be free from draw die marks, variations in wall thickness and faulty crystalline structure.

Clifford, being the first to produce hydraulically-formed bellows for industry, not only realizes the importance of metal selection, but also appreciates the critical nature of all processes involved in making bellows assemblies for controlling temperature and pressure; for sealing against pressure leakage; or for other exacting uses. *First with the Facts on Hydraulically-Formed Bellows.* Clifford Manufacturing Co., 561 E. First Street, Boston 27, Massachusetts.

CLIFFORD *Feather Weight* OIL COOLERS AND COOLANT RADIATORS

HYDRAULICALLY-FORMED BELLOWS

Laminated INSUROK T-712

Melamine Fiberglass Laminate—INSUROK T-712—is a brown plastic product of the type requested by the Navy for all electrical power, lighting, interior communications, fire control and other shipboard electrical installations

● Laminated INSUROK T-712 is superior to many other types of sheet insulation in fire and arc resistance. It has reduced toxicity in the case of unavoidable fires; does not readily support combustion; is higher in mechanical and electrical properties; lower in expansion under heat and moisture, and has high tensile and compressive strengths. Richardson Plasticians have also developed modern and economical methods of fabricating this product. Write today for complete information on Laminated INSUROK Grade T-712!

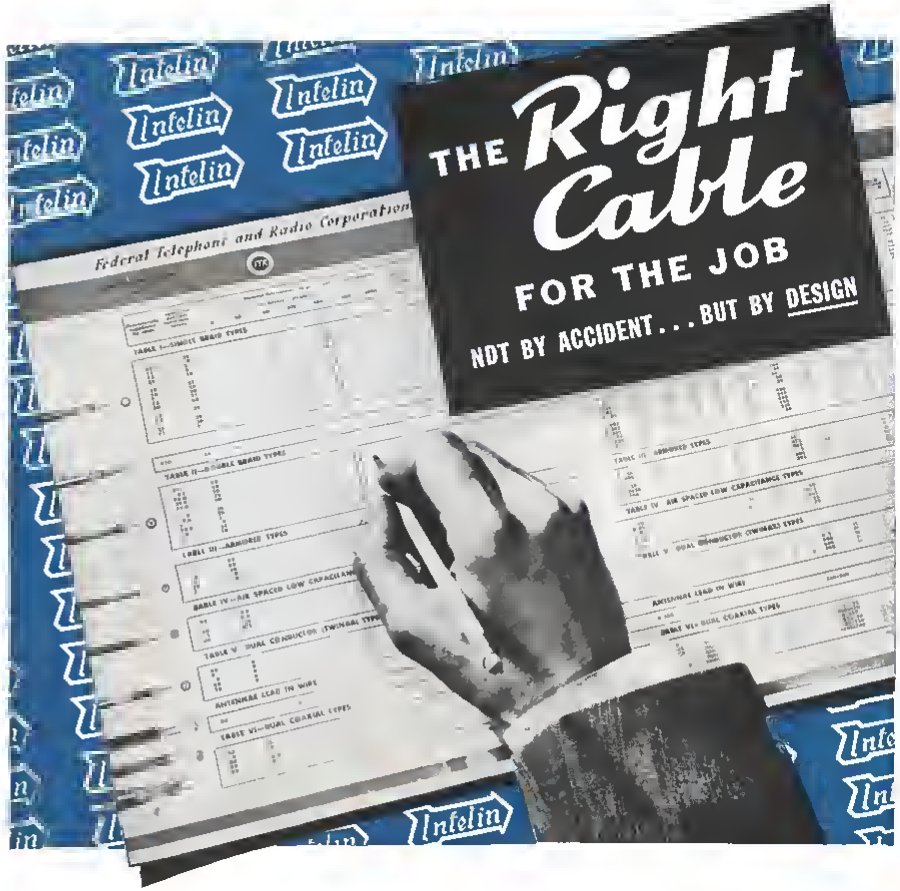
TESTS OF FACTORY-RUN INSUROK T-712
Made at Richardson Laboratories

Tensile strength ⅛" thickness	
Lengthwise	45,680 psi
Crosswise	37,900 psi.
Flexural strength ⅛" thickness	
Lengthwise	53,700 psi.
Crosswise	50,480 psi.
Compressive strength	
Flatwise (½"x½"x½")	97,800 psi.
Edgewise (½"x½"x½")	
Lengthwise	29,460 psi.
Crosswise	24,600 psi.
Impact strength (izod method) per inch of notch	
Flatwise (½"x¼")	
Lengthwise	Greater than 33 ft lbs.
Crosswise	27.4 ft. lbs.
Edgewise (½"x½")	
Lengthwise	18.8 ft. lbs.
Crosswise	16.5 ft lbs.
Bond strength ½" thickness	1,870 lbs.
Arc Test	185 sec.
Moisture Absorption ½" thickness	
24 hours in water at 77° F	1.04%
Dielectric Constant	5.65
Loss Factor	.0521
Dielectric Strength	
Short Time	590 volts/mil
Step by Step	410 volts/mil

INSUROK *Precision Plastics*

The RICHARDSON COMPANY

MELROSE PARK, ILL. NEW BRUNSWICK, N. J. FOUNDED 1858 INDIANAPOLIS 1, IND. LOCKLAND, CINCINNATI 15, OHIO
DETROIT OFFICE 6-252 G. M. BUILDING, DETROIT 2, MICHIGAN NEW YORK OFFICE 75 WEST STREET, NEW YORK 6, N. Y.
CLEVELAND OFFICE 326-7 PLYMOUTH BLDG., CLEVELAND 15, OHIO



To assist the equipment designer Federal offers comprehensive data on high frequency cables.

This technical information sheet provides the design-engineer with pertinent electrical and physical characteristics...including impedance, capacitance, attenuation, diameter, materials, and weight . . . for Federal's wide variety of high-frequency cables.

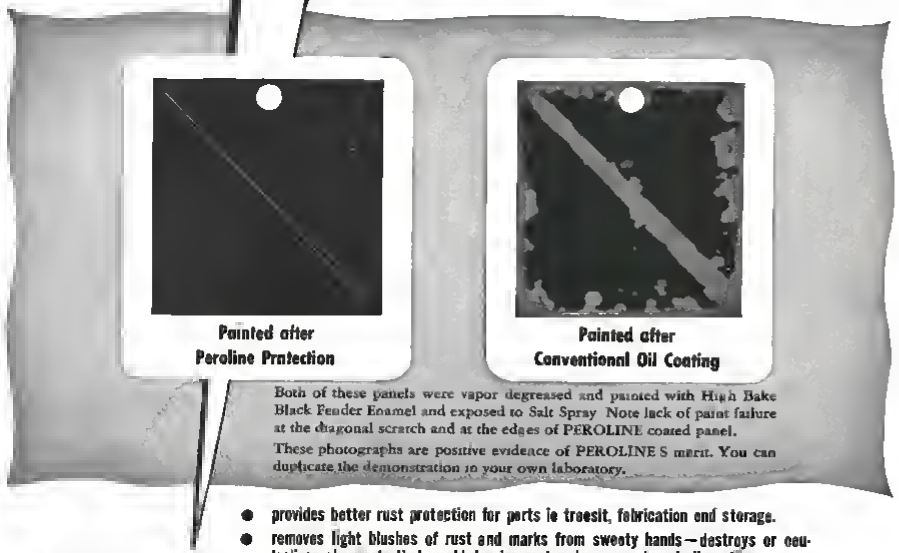
Single and double braid, armored, dual conductor and dual coaxial, air-spaced, low capacitance lines, and antenna lead-in wire . . . there's a right type for your job, backed by the built-in superiority that's a tradition with Federal.

Special developments in flexible low-loss cables by Federal have resulted in superior cables for all types of transmission. For a better job, see Federal first.

Write for your cable information sheet today.

Federal Telephone and Radio Corporation
An IT&T Associate
Newark 1, N. J.

Peroline PREVENTS RUST
PROPERLY CONDITIONS FOR PAINTING



Painted after Peroline Protection

Painted after Conventional Oil Coating

Both of these panels were vapor degreased and painted with High Bake Black Fender Enamel and exposed to Salt Spray Note lack of paint failure at the diagonal scratch and at the edges of PEROLINE coated panel.

These photographs are positive evidence of PEROLINE S merit. You can duplicate the demonstration in your own laboratory.

PEROLINE

- provides better rust protection for parts in transit, fabrication and storage.
- removes light blushes of rust and marks from sweaty hands—destroys or neutralizes chemicals that would develop rust under conventional oil coatings.
- produces a properly conditioned surface for durable paint finish when the oil phase is removed from the work with solvents or in a vapor degreaser.
- makes it possible to safely use a vapor degreaser in preparation for a durable paint finish.

PEROLINE, if applied to a clean surface, keeps it clean and leaves it properly prepared for finishing with no other treatment than to remove the oil phase by vapor degreasing or with suitable solvents or thinners.

The Technical Department of the American Chemical Paint Company will also gladly advise you regarding proper chemicals for your use in rust removing and metal cleaning both for war products and those for domestic use.

Send for PEROLINE *literature Department K-6.*

MANUFACTURERS OF INHIBITORS AND METAL WORKING CHEMICALS

AMERICAN CHEMICAL PAINT CO.
AMBLER ACP PENNA.

Note—West Coast Plants may address inquiries and orders for prompt delivery to Leon Finch, Ltd., 726 East 59th St., Los Angeles, California.

P-T BOAT*

Collins Radio Equipped

HERE ARE A FEW of many types of the Navy's small craft which maintain communication with this Collins designed TCS radio transmitter and receiver combination. This equipment is so sturdy, handy and reliable, and packs so much power and sensitivity into so little space, that it finds numerous Naval applications ashore as well as afloat. Usually the first radio installation on the beach-head, it is also standard on fire, rescue and crash trucks, and is often used on jeeps and command cars. The TCS is another example of the variety and quality of radio communication equipment Collins will be able to supply to industry after the war. Collins Radio Company, Cedar Rapids, Iowa; 11 West 42nd Street, New York 19, N. Y.

*Official U. S. Navy Photo

BOMB TARGET BOAT*

LVT-4 LANDING VEHICLE TRACK*

AIRCRAFT RESCUE BOAT*

ARMY E NAVY

IN RADIO COMMUNICATIONS, IT'S . . .

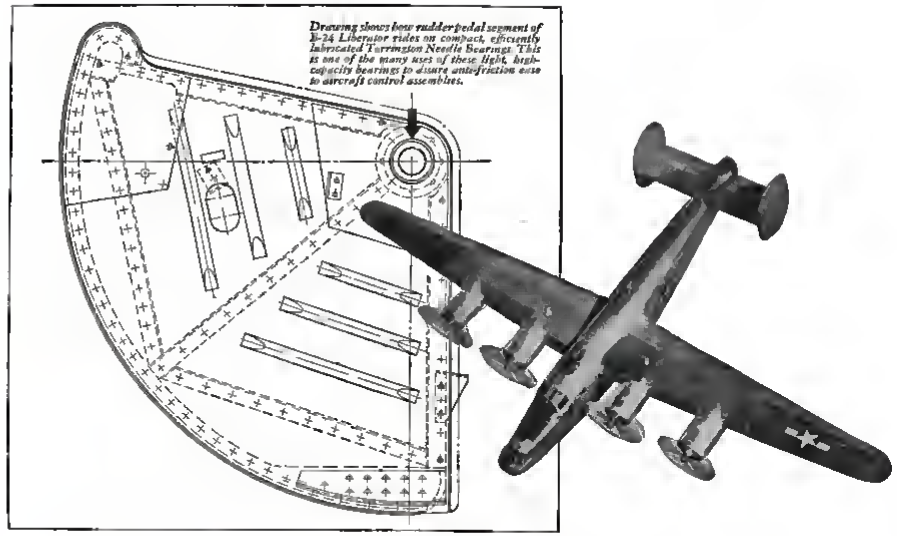
COLLINS

• During the war years, Breeze has produced in vast quantities essential equipment for our armed forces of land, sea and air which have helped bring Victory in Europe. Among the products which have borne the Breeze Mark of quality through wartime service are Breeze Radio Ignition Shielding Assemblies, Multi-lectric Connectors, Aircraft Armor Plate, Tab Control Systems, and Cartridge Engine Starters.

The diversified facilities and skilled hands which helped turn out this vitally important equipment will be available when final Peace comes to pitch in on the big job of reconversion. Until that time, the men and women of Breeze rededicate themselves to the task in hand — to keep production rolling on to ultimate Victory.

BREEZE
Corporations Inc.
NEWARK BREEZE NEW JERSEY

Other Breeze Products • FLEXIBLE METAL TUBING • SHIELDING CONDUIT • FITTINGS • FLEXIBLE SHAFTING



Rudder Pedal Segment of B-24 Liberator Rides on Torrington Needle Bearings

It is no surprise that the rudder pedal segment of the mighty B-24 Liberator, rides on light weight, compact Torrington Needle Bearings. For their full complement of small diameter needle rollers packs high capacity into small space, provides an extra margin of safety with the efficiency and reliability that is characteristic of these modern, self-contained anti-friction bearings.

Can you visualize these Torrington Needle Bearing advantages in terms of *your* product . . . aircraft or automotive equipment . . . machine or portable tools . . . household or other equipment that you want to operate with maximum ease, combined with minimum size, weight—and cost? Our Catalog 32, showing the wide range of types, sizes and applications, will help you. Write for it today.

•

THE TORRINGTON COMPANY
TORRINGTON, CONN · SOUTH BEND 21, IND.
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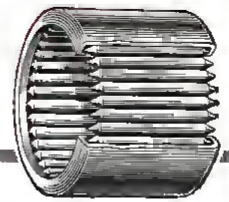


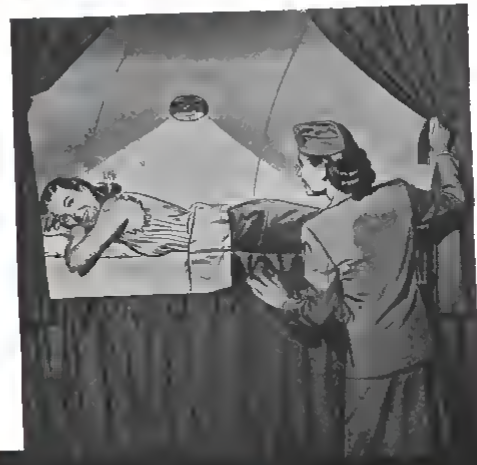
TORRINGTON NEEDLE BEARINGS

NOTHING UNDER A PILOT . . .

*Notice the countless tiny dots in the pilot seat cross-sectioned above. They're the famous Foamex comfort bubbles—breathing air and latex cells that put a cloud of comfort between your pilots and flying fatigue. There are millions of these cells in a Foamex-cushioned seat, and each one is a soft air cushion, a buoyant, springy cushion, a little air-valve shock absorber. They save nerves—promote efficiency, by treating muscles tenderly and by swallowing vibration and bumps.

NOTHING UNDER YOUR PASSENGERS rests them so luxuriously as *Foamex*. This Firestone upholstery cushioning provides resilience and softness in one zephyr-light material. See how *Foamex* molds itself to the girl's figure instead of molding her out of shape.

FOAMER MATTRESSES, REST IN THE AIR—because a few ounces of this air-bubbly material gives more body-cradling support than pounds of bulky oldstyle mattress. *Foamex* never "packs" hard under weight.



FOAMEX*

Latex Foam Seat Cushioning

- **HELPS PILOTS WORK**
- **HELPS PASSENGERS REST**

Look into the latest and greatest of the stratosphere cruisers and what do you find?

Foamex—fighting flying fatigue by seating personnel more comfortably . . . promoting air travel by resting passengers in out-of-this-world luxury.

Foamex is soft as air! *Foamex* is buoyant—it's rubber latex, bubble-foamed to super-resilience the exclusive Firestone way.

Foamex is air-cooled, air-cleaned. Millions of breathing pores keep it constantly ventilated—dustproof, damp proof, mildew-proof, odor-proof.

Rests maintenance folks, too. Makes their job a cinch, when it comes to keeping seats plump and neat. Replaces old-fashioned upholstery innards with one welded-together material.

It's sag-proof, lump-proof, practically wearproof. It always springs back to its original contours (you don't have to pound it back to shape after it's been sat on).

You don't have to tie up equipment to re-shape or re-stuff *Foamex*-upholstered seats. There's no stuffing in *Foamex* . . . only sheer comfort, good for the life of the plane.

The Army and Navy need *Foamex* to cushion airmen against fatigue, to shield men and instruments against battle concussion, for submarine, ship, and hospital mattresses. Soon, we hope, there'll be enough to go around for everybody.

*TRADE MARK

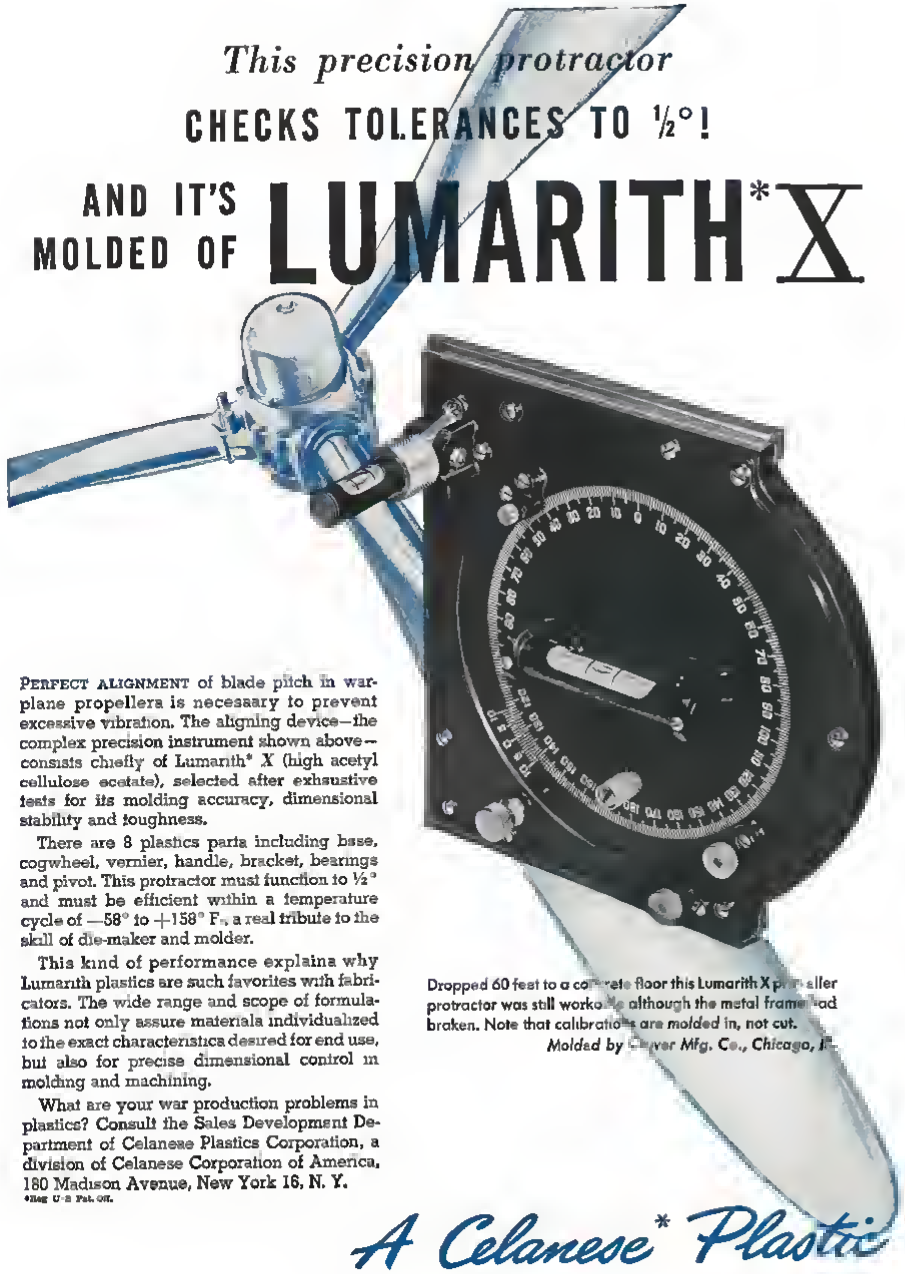
FOAMEX* SOMETHING BETTER TO SIT OR SLEEP ON by **Firestone**

LISTEN TO THE VOICE OF FIRESTONE MONDAY EVENINGS OVER NBC

This precision protractor

CHECKS TOLERANCES TO ½°!

AND IT'S MOLDED OF LUMARITH*X



PERFECT ALIGNMENT of blade pitch in warplane propellers is necessary to prevent excessive vibration. The aligning device—the complex precision instrument shown above—consists chiefly of Lumarith* X (high acetyl cellulose acetate), selected after exhaustive tests for its molding accuracy, dimensional stability and toughness.

There are 8 plastics parts including base, cogwheel, vernier, handle, bracket, bearings and pivot. This protractor must function to ½° and must be efficient within a temperature cycle of —58° to +158° F., a real tribute to the skill of die-maker and molder.

This kind of performance explains why Lumarith plastics are such favorites with fabricators. The wide range and scope of formulations not only assure materials individualized to the exact characteristics desired for end use, but also for precise dimensional control in molding and machining.

What are your war production problems in plastics? Consult the Sales Development Department of Celanese Plastics Corporation, a division of Celanese Corporation of America, 180 Madison Avenue, New York 16, N. Y.

*Reg. U. S. Pat. Off.

Dropped 60 feet to a concrete floor this Lumarith X protractor was still workable although the metal frame had broken. Note that calibrations are *molded* in, not cut.

Molded by Beaver Mfg. Co., Chicago, Ill.

A Celanese Plastic*

HOW UP-TO-DATE are you on ALUMINUM?

...now offers new combinations of advantages... new alloys in all forms... from a great new source!

Consider aluminum today in terms of recent advancements—particularly the new lightweight, high-strength aluminum alloys developed by Reynolds metallurgists.

For example...

CONSIDER R301, the new Reynolds alloy with a typical tensile yield strength of 60,000 p. s. i., superior workability, good corrosion-resistance, excellent spot-welding characteristics.

CONSIDER R303, another new Reynolds alloy with even higher tensile yield strength—higher, in fact, than any aluminum alloy used in the past. In addition, R303 has splendid corrosion-resistance.

CONSIDER ALSO R317, Reynolds new free-machining alloy.

And finally, consider all Reynolds aluminum alloys in terms of these additional advantages... ease of fabrication and assembly... thermal and electrical conductivity... heat and light reflectivity... non-magnetic, non-sparking and non-toxic qualities... pleasing appearance... new low costs.

Consider Aluminum—Consult Reynolds.

Keep your dollars fighting... Buy MORE War Bonds

REYNOLDS METALS

REYNOLDS *The Great New Source of* **ALUMINUM**

INGOT • SHEET • SHAPES • WIRE • ROD • BAR • TUBING • PARTS • FORGINGS • CASTINGS • FOIL • POWDER

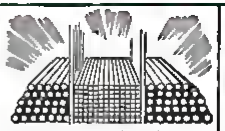
From Rivets to Armor Plate: Consult Reynolds

Today Reynolds Metals is sweeping forward as the nation's great new source of all forms of aluminum. Let Reynolds demonstrate what this all-out, tradition-free effort can do for you. Service offices located throughout the country.

See the Reynolds catalog in Sweet's—or write for bulletins outlined in the paragraphs below.

SHEET AND PLATE. Standard gauges, sizes, alloys. Special items. Bulletin 22-A gives specifications, ordering data, etc. 8 pp.

WIRE. Cross sections less than ½ inches. See Bulletin 31-A for specifications, ordering data, etc. 12 pp.



ROD AND BAR. Sizes from ⅛ inches to 8 inches for forging and machining. Bulletin 31-A gives complete information.

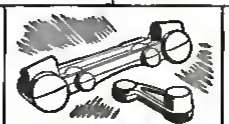
SHAPES. Rolled and extruded sections to fulfill individual needs. See Bulletin 35-A for full information. 8 pp.

TUBING. Seamless. Closely controlled as to quality and dimensions. See Bulletin 17-A. Specifications, ordering data, etc. 8 pp.

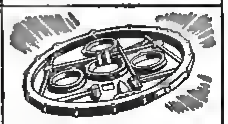
PARTS. Fabrication of aluminum source saves manpower, plant space, scrap and transportation. Ask for further information.

FOIL. For years the largest producer of light-gauge aluminum for packaging, technical and insulation purposes. Bulletin on request.

POWDERS AND PASTES. For aluminum coatings. Bulletin 21-A gives forms, applications, evaluations. 20 pp.



FORGINGS. Production capacity up to 2,000,000 units per month. Ask for details.



CASTINGS. Permanent mold and sand. Produced in one of industry's most modern plants. Ask for further information.

FREE! Many of the bulletins mentioned above belong in your files for quick reference. Please use coupon in requesting.

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Aluminum Division
2536 South Third Street, Louisville 1, Kentucky
Send post-free material I have listed:

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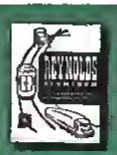
FIRM_____
STREET_____ TITLE_____
CITY_____ ZONE_____ STATE_____



DON'T MISS THIS!

"Reynolds Aluminum, Its Important Role in Tomorrow's Products," is of direct interest to every one concerned with design and production. 16 pages packed with useful information.

GASKETS

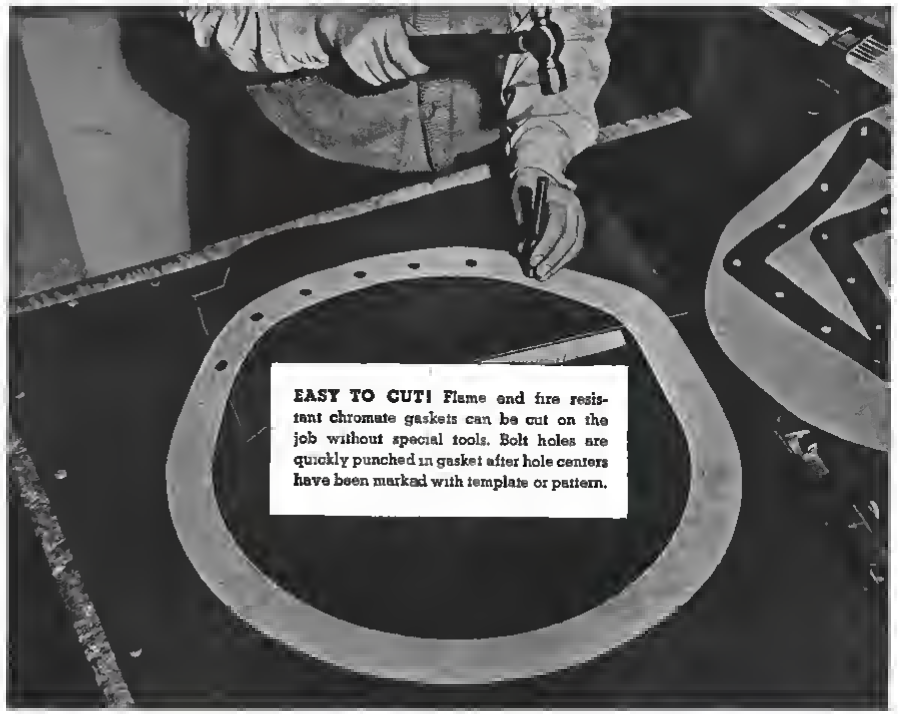
NOW NEED NO RUBBER!

PERFECT FIT! Flexible, non-drying gasket is fitted to ventilator joint. Chromate-treated felt has rust and corrosion-proof properties, permits long exposure without decomposition.

READY! Ventilating joint, with gasket on flange, is placed in position, ready to be bolted.

"MAKING" THE JOINT by bolting one flange to another. This joint, made at "bulk-head," is sealed air and water tight. Gaskets normally maintain air pressures of 25 lbs. per square inch.

SHERWIN-WILLIAMS



EASY TO CUT! Flame and fire resistant chromate gaskets can be cut on the job without special tools. Bolt holes are quickly punched in gasket after hole centers have been marked with template or pattern.

Flame-Resistant Chromate Gaskets Developed by SHERWIN-WILLIAMS Technicians!

Rubberless gaskets—another Sherwin-Williams first! Another achievement of the famous S-W technical force! Another big S-W help to Uncle Sam—for these new-type chromate gaskets are used exclusively by shipbuilders on U. S. Navy and U. S. Maritime Commission vessels. They are now available only for implements of war.

Developed to replace vital sponge rubber, chromate gasketing is made of flexible wool felt impregnated with a specially prepared chromate pigment compound. It seals flange-to-flange joints and other connections in ventilating, plumbing, fuel oil, and diesel oil systems . . . wherever air-, oil-, and water-tight joining is necessary!

For up-to-the-minute developments in the field of industrial finishes, look to Sherwin-Williams! Perhaps we can help you! Write the Sherwin-Williams Co., Cleveland 1, Ohio.

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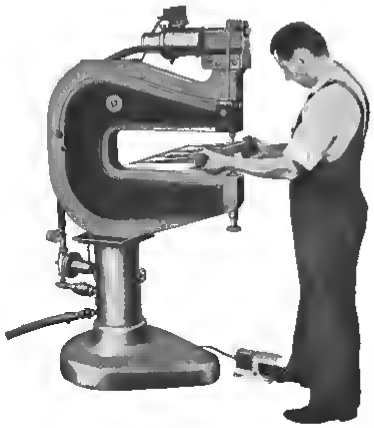
WORLD'S LARGEST LINE OF AVIATION TOOLS...

Chicago Pneumatic—first to design and produce a pneumatic riveter for airplane fabrication—kept pace with expanding peacetime requirements of the aviation industry. In meeting the industry's vastly accelerated war time demands, CP re-emphasized its leadership. Today, Chicago Pneumatic manufactures the largest line of aviation pneumatic and electric tools in the world—a wide variety of stylea and sizes to fill every production need. Only a few of the many CP Aviation Tools are shown here. Complete information on any tool—or tools—supplied upon request.

RIVETING HAMMERS

CP Slow-Hitting Aero Riveting Hammers deliver just the right impact to insure properly driven rivets.



COMPRESSION RIVETING-DIMPLING MACHINES

CP 450-EA Compresaion Riveting-Dimpling Machine permits faster riveting and dimpling. Automatically compenastes for variation in stock thickness or rivet length. Stock thickness may vary as much as ½" when driving 3/16" or smaller rivets ... up to 5/32" when driving ¼" diameter rivets. A simple pass over the work completes the job.

COMPRESSION RIVETERS

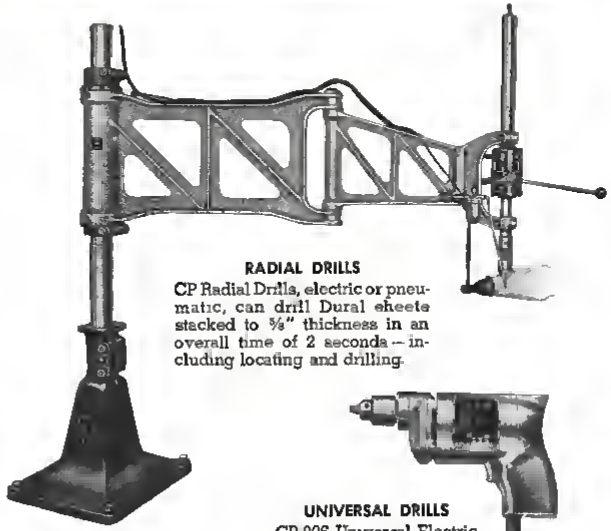
CP has a complete line of portable, semi-portable and stationary compression riveters to meet practically any requirement.

IMPACT WRENCHES

CP Pneumatic Wrenches (Impact Type) speed application or removal of nuts, screws etc.

HYDRAULIC POWER MACHINE

CP Hydraulic Power Machine, developing pressures up to 100 or more tons, speeds output—cut costs in high speed production riveting, including multiple riveting and punching.



RADIAL DRILLS

CP Radial Drills, electric or pneumatic, can drill Dural sheets stacked to ⅝" thickness in an overall time of 2 seconds—including locating and drilling.

UNIVERSAL DRILLS

CP 806 Universal Electric Drills for close quarter drilling up to ¼".

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CP Light-Weight Pneumatic Production Drills are ideal for women operators; available in a wide range of sizes and capacities.

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CP-157T Hicycle Electric Tappers equipped with adjustable slip clutch. Slight backward pull engages reversing gears to back tap out of threaded hole.

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- Slow Hitting
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- Yoke
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- Hicycle Electric

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- Pneumatic (Impact Type)

Screw Drivers
- Pneumatic
- Universal Electric
- Hicycle Electric

Nut Runners
- Pneumatic
- Universal Electric
- Hicycle Electric

Grinders and Sanders
- Pneumatic
- Universal Electric
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Tappers
- Pneumatic
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- For Tools Or Objects Weighing Up To 300 Pounds

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What will the Air World be like?

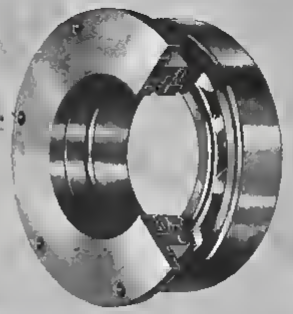
Thanks to the aviation industry, it will be a small world. The airplane, spanning the globe in regular, daily commercial flights—no matter what the weather—can make "good neighbors" of all nations. Encouraging air travel is the job not only of the aircraft industry, but also of the makers of communications and other electronic equipment for use in aviation. And there you'll find Western Electric still leading the way.

During the Seventh War Loan Drive, buy bigger, extra War Bonds!

Western Electric

Distributed by Graybar

RADIO AND OTHER ELECTRONIC EQUIPMENT FOR A WORLD ON WINGS

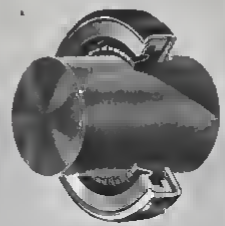


HIGH SPEED SEAL (FLANGE TYPE)

HIGH SPEED SEAL (PRESS FIT TYPE)

PRODUCTS OF SPECIALIZATION

FELT OIL AND GREASE SEAL



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PRECISION SEAL

GITS

TRADE MARK REG U S PAT OFF

OIL AND GREASE SEALS

Specialization has taught industry many lessons in higher, precision standards and equally as many lessons in true economy. Where lubrication is a requisite—only the highest standards can be true economy. Gits has specialized for over 35 years in exclusive research of lubrication methods and the development and manufacturing of a wide range of seals and lubricating devices to safeguard machinery investments of unlimited value and eliminate the ever present danger of production stoppage. These years of specialization by Gits, have produced intangible values that insure dependable performance under all conditions. These years of specialization have indelibly specified the name Gits wherever lubrication is an essential. Ask Gits for a specialized answer to your problems.

GITS BROS. MFG. CO.

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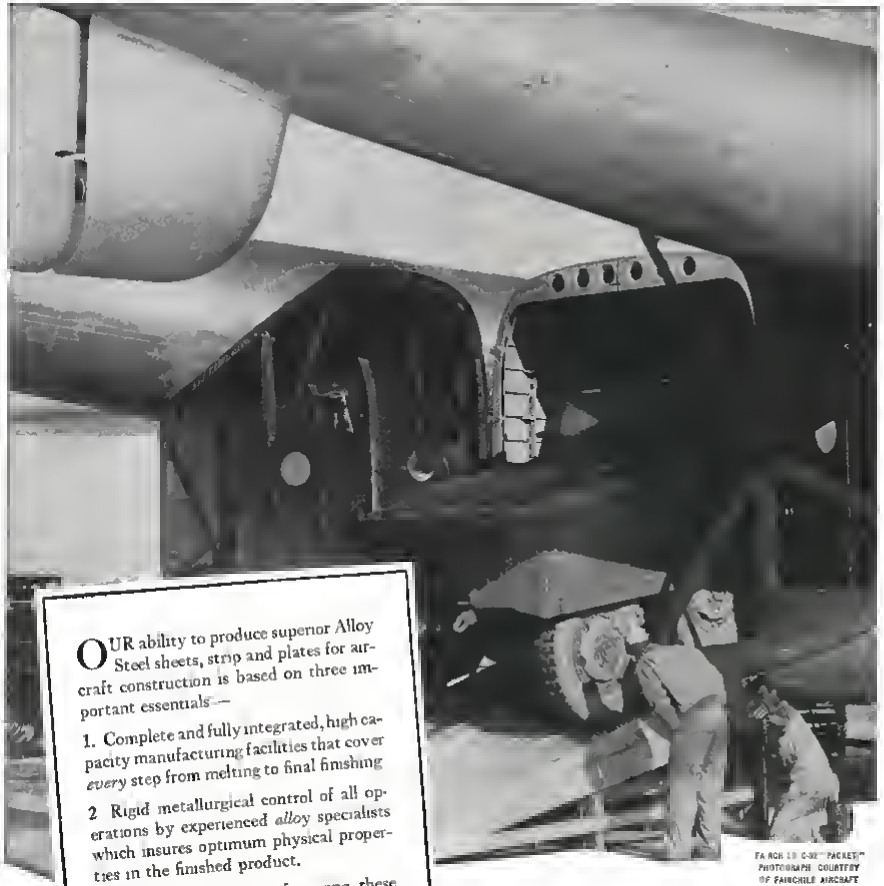
Request your copy of Gits catalog No 60 —the encyclopedia of lubricating devices

Exclusive for over 35 years



FA AGR 10 C-32 "PACKET" PHOTOGRAPH COURTESY OF FAIRCHILD AIRCRAFT

OUR ability to produce superior Alloy Steel sheets, strip and plates for aircraft construction is based on three important essentials—

1. Complete and fully integrated, high capacity manufacturing facilities that cover *every* step from melting to final finishing.

2. Rigid metallurgical control of all operations by experienced *alloy* specialists which insures optimum physical properties in the finished product.

3. Equipment for manufacturing these flat-rolled products surpassed by none in the steel industry. It includes the most modern equipment for rolling and bright annealing to meet the exacting standards of surface quality for aircraft applications.

U·S·S CARILLOY
Aircraft Quality
ALLOY STEELS

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USS STEEL — MADE IN THE UNITED STATES OF STEEL

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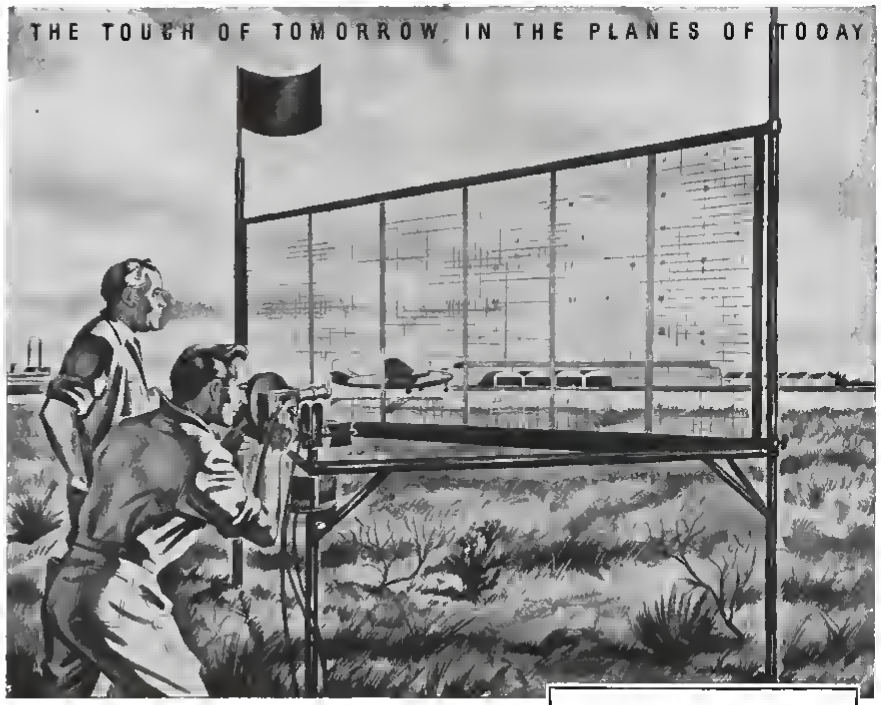


SCREEN TESTS FOR A NEW STAR

Across the "screen" flashes an airplane powered by the latest model Ranger engine.

Its progress is recorded on film.

Does its performance surpass expectations? What's the exact rate of climb from the take-off? Is the propeller and engine combination correct?

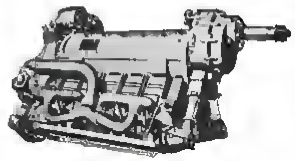
Study of the screen test films will show.

Through this and other carefully controlled scientific testing, Fairchild engineers are proving the efficiency, versatility and endurance of Ranger engines.

Constantly improved since its inception, the Ranger engine today packs more power into an even more efficient package. Fairchild research and engineering skill have developed a flying power plant that is "inline for the airlines."

The emphasis is on efficient horsepower production; length of service between overhauls; ease of maintenance; and economy.

Today, flying over test fields in ships that are basic designs for the airplanes of tomorrow, Ranger models, like all products of Fairchild research and experience, provide a "touch of tomorrow in the planes of today."



THE RANGER TWELVE

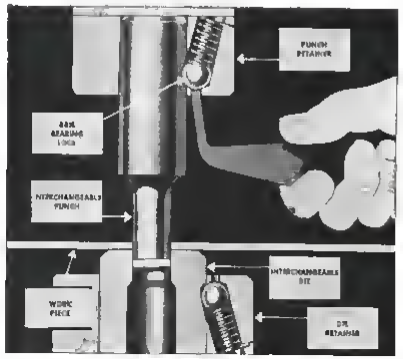
Skillful engineering has built these qualities into Ranger engines:

- High speed for *smooth* power
- Inverted for a wider field of vision
- Inline for minimum drag and maximum flexibility
- Aircooled Al Fin cylinders for greater power
- Precision construction and quality materials for long life

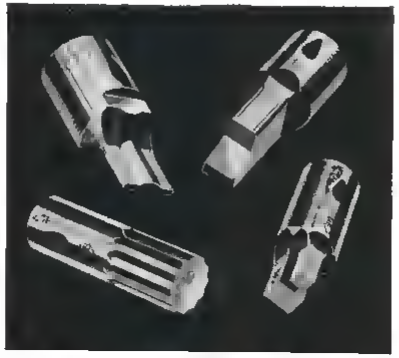
BUY U. S. WAR BONDS AND STAMPS

RANGER AIRCRAFT ENGINES

Division of Fairchild Engine and Airplane Corporation • Farmingdale, Long Island

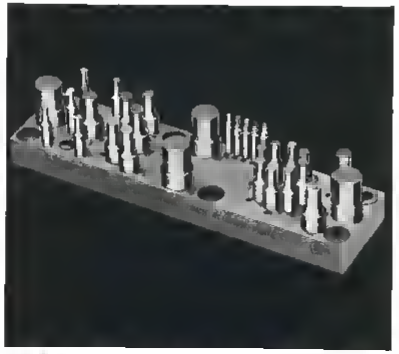


Showing the method of releasing either the punch or die simply by depressing the ball bearing with special hand tool provided. Unnecessary to remove die from press.



A few of the special shapes produced in R-B Interchangeable punch points. They may be made of any material and in any shape or size to fit your job.

Service with a punch!



Special punch retaining plates are made where center distances are too close to use standard retainers. Hole sizes can be changed without affecting plate pattern.

WITH THE R-B INTERCHANGEABLE PUNCH AND DIE

For years Allied's R-B Interchangeable Punch and Die has been in the service of the metal working industry—delivering a knock-out blow to production delays and high labor costs. Today it has become an accepted standard of efficiency in the field of laminated plastics as well. The wide application and money-saving possibilities of this "first aid" to multiple punching operations is indicated by the illustrations on this page.

Get a complete pre-view of Service With a Punch by studying the R-B catalogue carefully. It illustrates, lists, gives exact dimensions of and makes valuable suggestions for using the R-B standardized retainers, interchangeable punches and dies, composite die sections, rubber strippers, guide pins, bushings and other accessories . . . and it contains additional data and information that makes it a valuable book for any mass production manufacturer.

The R-B Catalogue will be mailed without charge. Use your letterhead to send for a copy, now.

"IT'S AN ALLIED PRODUCT!" . . . Allied Products Corporation in its plants in Detroit and Hillsdale, Michigan, makes cold forged parts, cap screws, sheet metal dies (from the largest to the smallest), R-B interchangeable punches and dies, steam-heated plastic molds, jigs and fixtures and special production tools.

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IF IT'S AN ABRASIVE TOOL . . . "CARBORUNDUM" MAKES IT!

EVERY once in a while, somebody tells us that the reason be's not using an Abrasive by "CARBORUNDUM" on a particular job is because "CARBORUNDUM" doesn't make an abrasive product for that job. Tbat always surprises us. For actually tbere's an abrasive product by "CARBORUNDUM" for all abrasive applications used by modern industry. You see, Tbe Carborundum Company pioneered the use of man-made abrasives. For over half a century, "CARBORUNDUM" abrasive engineers have been working witb tool and production engineers and others in industry to help perfect better ways of doing things through the effective use of abrasive tools

Today, Abrasives by "CARBORUNDUM" are used in almost every industry and for a multitude of purposes. Many users specify these products for all their requirements. Wbenever you need help with your abrasive problem call the "CARBORUNDUM" representative. Tbe Carborundum Company, Niagara Falls, N. Y.

("CARBORUNDUM" is a registered trade mark of and indicates manufacture by The Carborundum Company)

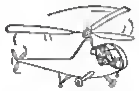
Fiberglas plastics fabrications by United States Rubber Company for Nash Kelvinator Corporation.

Fiberglas—glass in the form of fine fibers—twisted into yarn and woven into cloth, possesses many of the properties most sought after in low-pressure laminates.

FIBERGLAS*– REINFORCED PLASTICS

—a spectacular, new, lightweight

Structural Material



Aircraft structural parts, such as the cabin structure of the Army R-6 Helicopter, are now being made of plastics reinforced with Fiberglas — fine filaments of glass woven into cloth, then used with low-pressure resins in the fabrication of extremely strong, lightweight laminated plastics parts.

Fiberglas textiles are resistant to moisture, therefore are dimensionally stable. They possess great tensile strength, and are resistant to heat, oils, corrosive vapors and most acids.

The combination of Fiberglas and certain low-pressure resins has resulted in a material with properties which excel those of any material previously available for commercial use. For example, impact strength from five to ten times that previously obtained in laminates is now attained through Fiberglas reinforcement. Higher strength-to-weight ratios, greater rigidity, dimensional stability and simplified fabrication are but a few of the advantages which are resulting in the rapidly increasing use of Fiberglas for reinforced plastics sheets and formed parts.

Samples and complete information on Fiberglas Textiles will be sent to you on request. Owens-Corning Fiberglas Corp. does not manufacture resins or finished laminates but will be glad to furnish data on techniques in the use of Fiberglas and low-pressure resins. Write *Owens-Corning Fiberglas Corp., 1891 Nicholas Bldg., Toledo 1, Ohio In Canada, Fiberglas Canada Ltd., Oshawa, Ont.*

R-6 cabin structure of Fiberglas-reinforced plastic being trimmed and made ready by U.S. Rubber for shipment to Nash-Kelvinator

The R-6 Helicopter which will be used to transport wounded from inaccessible combat areas and will service military outposts with supplies.

FIBERGLAS .. *A BASIC MATERIAL*

*T. M. Reg. U. S. Pat. Off.

Every MANUFACTURING CUSTOMER Will Benefit

Industrial users of WILCO Products will find the increased facilities, the new products and techniques developed by WILCO for war service of great advantage to their own postwar products.

As the Hourglass indicates . . . with the coming of peace, many WILCO products now making for precision performance in airplanes, ships, tanks, guns and instruments of the Army and Navy will play an equally important role in meeting civilian needs for hundreds of useful and reliable products.

The demand of all branches of the service for Thermostatic Bimetals and Electrical Contacts has motivated many WILCO developments of great potential value to postwar industry. New products added to an already extensive line, increased facilities for refining and fabricating precious metals; greatly extended rolling mill facilities—these new additions and improvements, now devoted principally to the war effort, will prove equally helpful to manufacturing customers in meeting their peacetime production and marketing problems.

WILCO PRODUCTS ARE: *Contacts*—Silver, Platinum, Tungsten, Alloys, Sintered Powder Metal. *Thermostatic Bimetal*—High and Low Temperature with new high temperature deflection rates. *Precious Metal Collector Rings* for rotating controls. *Silver Clad Steel*—for bearings, shims, reflectors. *Jacketed wire*—Silver on Steel, Copper, Invar, or other combinations requested. *Rolled Gold Plate.* Special materials.

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WILCO

Thermometals—Electrical Contacts
Precious Metal Bimetallic Products

Egg-laying Party - OVER TOKYO

Tumbling lazily out of yawning bomb bays, ton upon ton of explosives rain into the heart of the Japanese empire.

Unlike an earthquake, this destruction is pin-pointed where it will do the most harm. Unlike an earthquake, it keeps on day after day after day with increasing intensity.

Today, up to 300 Boeing Superforts wing over Japan at one time. Tomorrow, according to General Arnold, this number will be doubled, tripled, quadrupled. The Rising Sun will be blotted out once and for all by these deadly swarms.

We are proud that CECO carburetors have met the rigid standards of perfection required of every part in the mighty Wright engines on these B-29's. We intend to keep on building them that way — in quantity.

CECO

CARBURETORS
FUEL PUMPS
PROTEK-PLUGS

CHANDLER-EVANS CORPORATION SOUTH MERIDEN CONNECTICUT, U.S.A.

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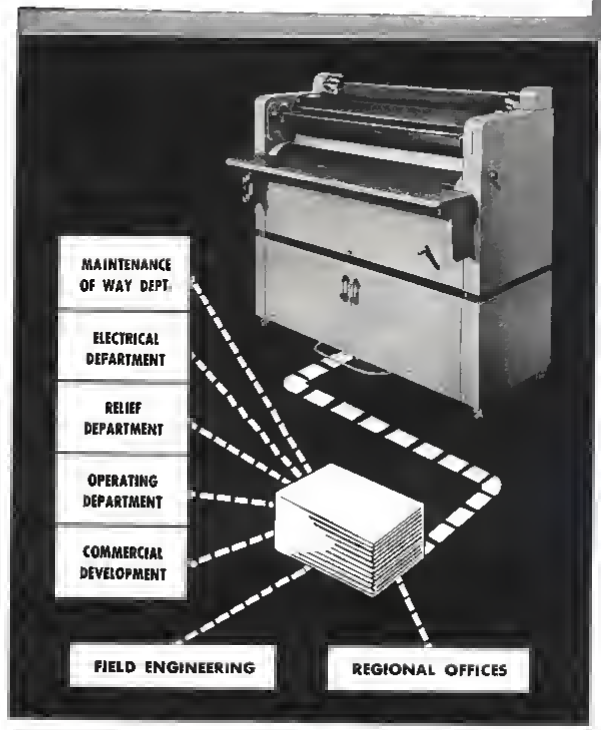

REPRODUCTIONS: VERSATILITY

DATA FOR ENGINEERING

The Baltimore & Ohio Railroad realized the wartime danger to many thousands of irreplaceable deeds, blueprints, documents and maps, and in 1942 deemed it necessary to make and store duplicates at safe inland points.

With the vexing problem of vast duplications before them, the engineering department immediately installed one of the first Continuous Model G-13 Portagraphs produced by Remington Rand.

In the first six months of operation, 5400 feet of copies were produced at a cost of less than $1,000. *Estimated cost of making them manually was $8,000.*

Meanwhile other departments, including the Maintenance of Way, Electrical, Relief, Operating, Commercial, etc., learned how many types of work Portagraph was doing, and the Engineering Department gladly took work for them — copies of drawings, maps, and other papers of every description.

Thus Portagraph, with its amazing versatility, brought to its owner dollar economies and savings of valuable man-hours far beyond those anticipated at the time of purchase.

Write, phone or wire our nearest Branch Office for full details.

5 MODELS FOR EVERY PHOTO-COPY NEED

MODEL G-13 — Continuous — with a 42" width reproduction capacity. Unsurpassed for making photo-copies of tracings, drawings, maps, blue prints and handling large volume copying.

MODEL G-12 — Vacuum Seal — Sizes 30" x 40" and 40" x 50". Ideal for making contact prints of anything drawn, printed or written.

MODEL G-11 — 20" x 24" width. Contact photo-copies are inexpensive and easy to produce on the G-11 Portagraph. Inexperienced operators obtain perfect results using G-11's electrical micro-matic timing switch.

MODEL G-10 — Excellent for general office use, copies any record up to 9½" x 15". Requires no dark room. Will copy from single page or bound book.

MODEL G-9 — A low cost unit of high efficiency for general office use, only $59.50. Equipped with a manual timing control.

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YOU MAY OBTAIN FREE OF CHARGE from our nearest Branch Office a copy of "How To Reduce Costly Manual Tracing, Drawing and Copying." This helpful 20 page book of practical information contains many time and labor saving ideas for the engineering office. Phone, write or wire for a copy.

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MICRO SWITCH

ROTARY "H" HOUSING

is adjustable

through 360 degrees

Here's Something *New*

IN AIRCRAFT LIMIT SWITCHING

Micro Switch brings to the aviation industry the new Rotary "H" housing in which the switch is operated by rotary actuation . . . something new in aircraft limit switching.

This newest addition to the famous Micro Switch Type "H" housings has a lever arm adjustable through 360 degrees, which can be directly link-connected to other mechanisms.

The Rotary "H" housing is of die cast aluminum and may be sealed against dirt, splash, or oil. The AN type conduit fitting is adjustable. Mounting holes are symmetrical and make possible four-position mounting on either face.

This new housing accepts AN-S-39 switches and will accept any basic pin plunger "Z" type switch, including the split contact type.

This new Micro Switch Type "H" housing is the latest addition to the Micro Switch line of aluminum housings which are standard equipment on all types of military and commercial aircraft. Their long operation life assures reliability and a minimum of maintenance. Their ruggedness, light weight, and compactness, most exactly meet the needs of aircraft usage.

SEND FOR THIS CATALOG

For complete details on Micro Switch snap-action switches, actuators, and housings for aircraft use, send for Micro Switch Handbook-Catalog No. 71. We will supply as many copies as your engineers require.

LET'S ALL BACK THE ATTACK — BUY EXTRA WAR BONDS

© First Industrial Corporation

MICRO MS SWITCH

TRADE MARK

A DIVISION OF FIRST INDUSTRIAL CORPORATION

Freeport, Illinois, U. S. A., Sales Offices in Principal Cities

The basic switch—a thumb size, feather-light, plastic enclosed, precision, snap-action switch. Underwriters' listed and rated at 1200 V.A., at 125 to 460 volts a-c. Capacity on d-c depends on load characteristics. Accurate reproducibility of performance is maintained over millions of operations. Basic switches of different characteristics are combined with various actuators and metal housings to meet a wide range of requirements.

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THE Crescent NCRE, shown above saving time and manpower for The Trailmobile Company, Cincinnati, O., is the most flexible of all lift trucks. The NCRE can be used for lifting, tiering or trailing. Equipped with a 62" lift, it will operate inside any standard boxcar. Available in 4000-lb. and 6000-lb. lifting capacities.

Crescent *Electric* Trucks increase the speed of material handling and at the same time reduce labor costs because they effect drastic manpower savings. Careful designing and superior construction are responsible for their ability to withstand the hard usage they get these busy wartime days. Maintenance costs are negligible. Crescentize your plant and watch those handling headaches fade.

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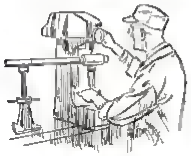
FREE CATALOG to help you select the right Crescent Electric Trucks for your plant is yours for the asking. It includes photographs and specifications for all current models. Send for your copy today.

Crescent ELECTRIC TRUCKS AND TRACTORS

Industrial Truck and Tractor Specialists Since 1917

Testing Saddle Cross Slide, Dovetail for Squareness with Lathe Bed Ways.

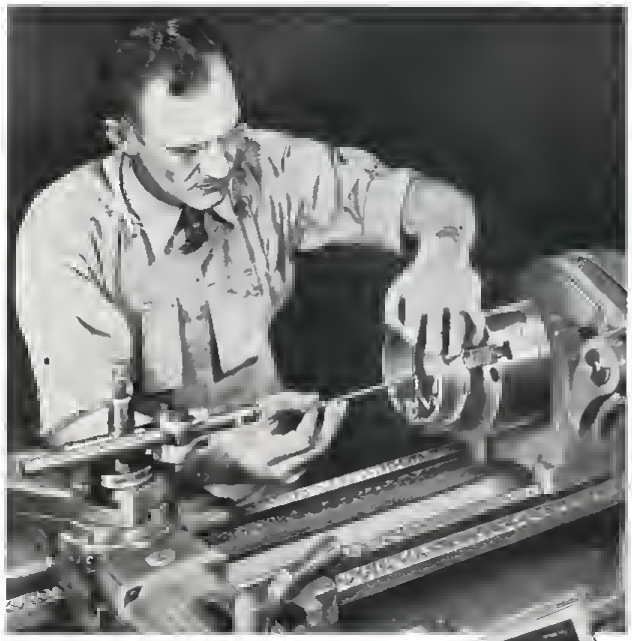
PRECISION IS *Built In* IN SOUTH BEND LATHES



Testing the Hardness of a Carburized Headstock Spindle Bearing Surface.

Checking a Fixture with Precision Gages.

Inspecting Form and Lead of a Screw Thread with an Optical Comparator.



The "built-in" precision of South Bend Lathes, so evident in their performance, has its source not only in their design features, but in every vital part. Each part has behind it the experience of thirty-eight years of lathe building, plus constant research directed towards its improvement. Backing this up in every manufacturing process are rigid controls that prevent deviations from established standards. These are a few of the reasons why South Bend Lathes are better today in every way.

This "built-in" precision makes possible heavier cuts and feeds, easier operation, longer life, and greater accuracy. It pays dividends to the users of these lathes in better and faster machining. Examine your metal working requirements in view of the advantages that can be obtained through the use of South Bend Lathes.

Write for
NEW LATHE CATALOG 105-D
Illustrates and describes all South Bend Lathes. Engine Lathes and Toolroom Lathes with 9", 10", 13", 14½", and 16" swings. Precision Turret Lathes with ½" and 1" collet capacities.

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553 EAST MADISON STREET • SOUTH BEND 22, INDIANA
LATHE BUILDERS FOR 38 YEARS

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With the coming of peace and a return to the American way of producing goods at a profit in highly competitive consumer markets you'll *have* to be certain that every step from initial blueprint and tool design, through the machining, stamping and assembly line, up to packaging and delivery is planned and executed with utmost efficiency and with the minimum of cost.

In the production of war munitions Oiljak has maintained an enviable record of production of intricate parts and on time deliveries, in accordance with strict Government inspection—and has actually reduced the estimated and approved cost, thus saving the Government considerable sums, by skillful planning and supervision of the work. These same skills in metal manufacturing, improving designs and reducing costs are available to manufacturers as they convert to peacetime merchandise. It may transmit your penny savings into dollar profits to confer with us on any metal manufacturing problem.

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METAL MANUFACTURERS

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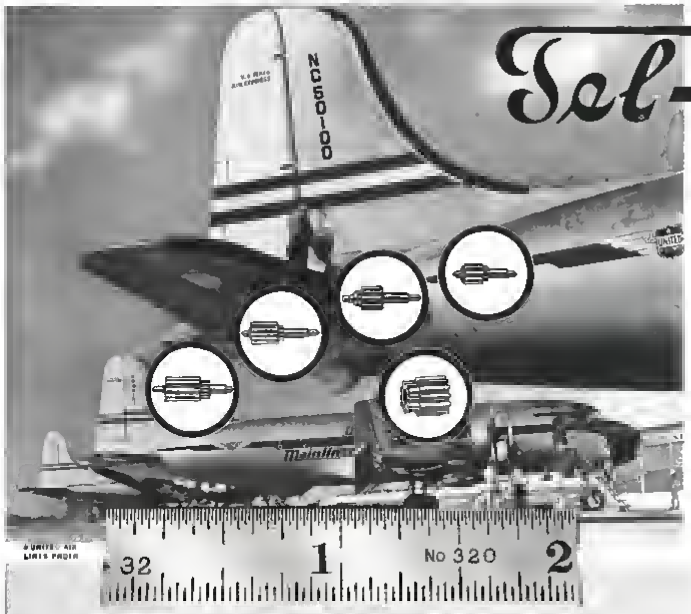

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"MEANS ACCURACY"

ANOTHER TEL-AIR PART

Small Tel-Air gears showing comparative size.

RULE shows how small these little pinions are—yet tiny gears like these have a vital part in the success of a giant machine's operation.

THE BIG JOB *of the* TINY GEAR

ABSOLUTELY UNIFORM PRECISION, tolerance, and concentricity in every machining and finishing operation — these are essential factors, the perfection of which spells Tel-air ACCURACY.

Bomb Fuzes, in which the pinions illustrated are used, and hundreds of other intricate component parts bear witness to the dependability of Tel-air precision engineering.

Right now ALL Tel-air production is devoted to the final push to end the war as soon as possible.

If you have any product using tiny mechanisms which must operate with unfailing precision and accuracy—we can make them to your complete satisfaction. We have an enviable record for deliveries on schedule.

BUY MORE WAR BONDS *Now!*

*Planes illustrated are the 4-engine type which United has ordered for post-war service.

In the Air it's Tel-air

The TELEOPTIC Company
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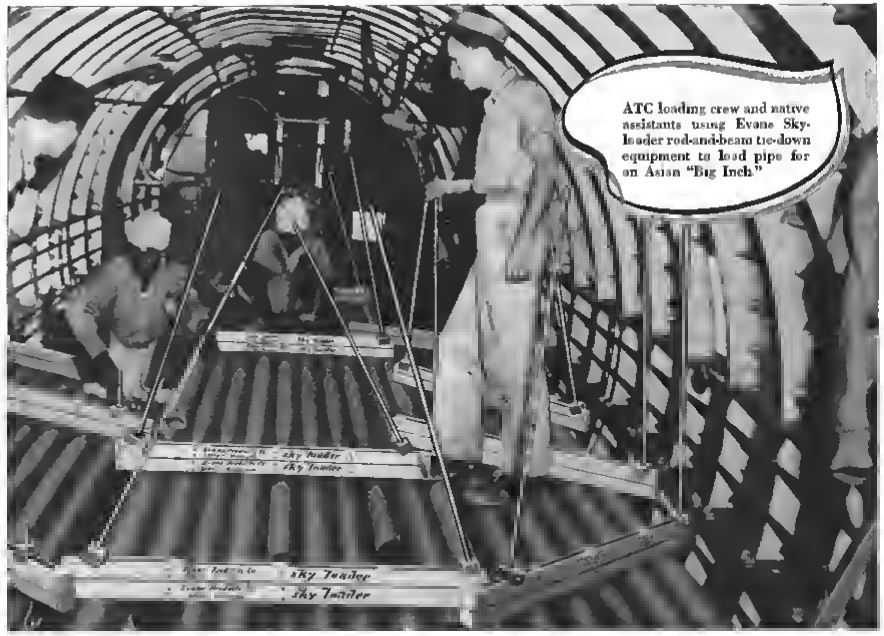
On the Highway it's Teleoptic



Safety Belts for the "Big Inch"

• "Somewhere in" Burma or China or India oil and gasoline for the engines of war were urgently needed. So the Army Air Forces Air Transport Command "Skyloaded" their transport planes with mile after mile of the heavy pipe and flew it all out to build a great pipe line—an Asian version of America's "Big Inch."

Yesterday, it would have been fantastic. Today, it's a vivid illustration of the part Evans Sky Products play in modern air transportation. Regardless of shape, size or weight, air-cargoes are tied-down by Evans Skyloader equipment—the "safety belt" that protects the cargo against damage, breakage and shifting, and the plane against injury. Write for a copy of the latest issue of "Sky Loadown," a breezy, informative pamphlet you'll be sure to find interesting.

Pioneers in the development of loading equipment for both land and air transportation, Evans engineers are planning now for wider-than-ever peacetime use of Skyloader equipment—Safety Belts for Air Cargo.

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SKY PRODUCTS DIVISION

EVANS PRODUCTS COMPANY
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with 3000 p. s. i. Closing and Holding Pressure

Using 10 GPM and 20 GPM Low Pressure Pumps
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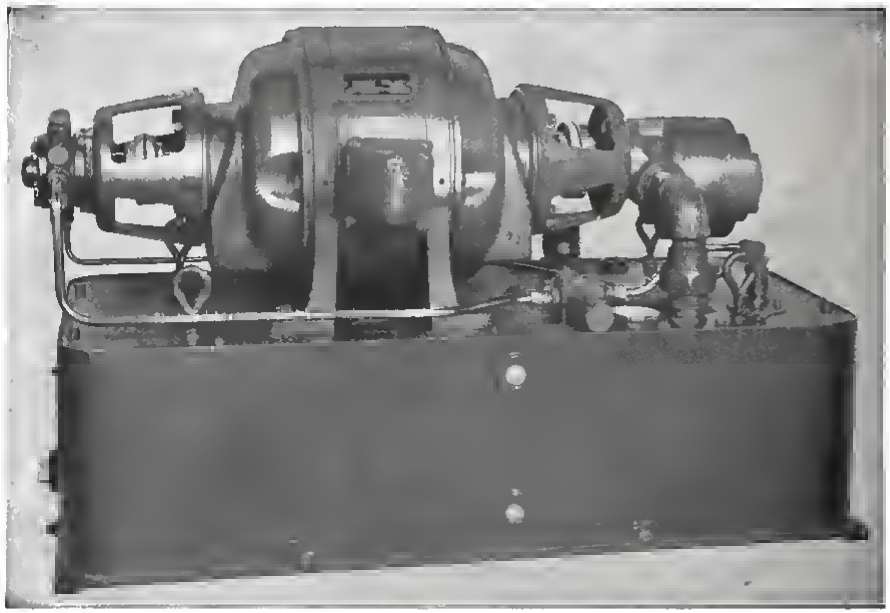
Units Complete with Pumps on Double End Motor . . . Unloading and Relief Valves
and Micronic Filter . . . All Mounted on 40 Gal. Water Cooled Reservoir



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For more than a third of a century HICKOK instruments have been noted for high precision, fine accuracy and long life. That is why they have long been held in highest esteem by the men who know meters and instruments. Write for catalogue.

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It's a salute to you . . . to every man and woman working in America's great Aviation Industry.

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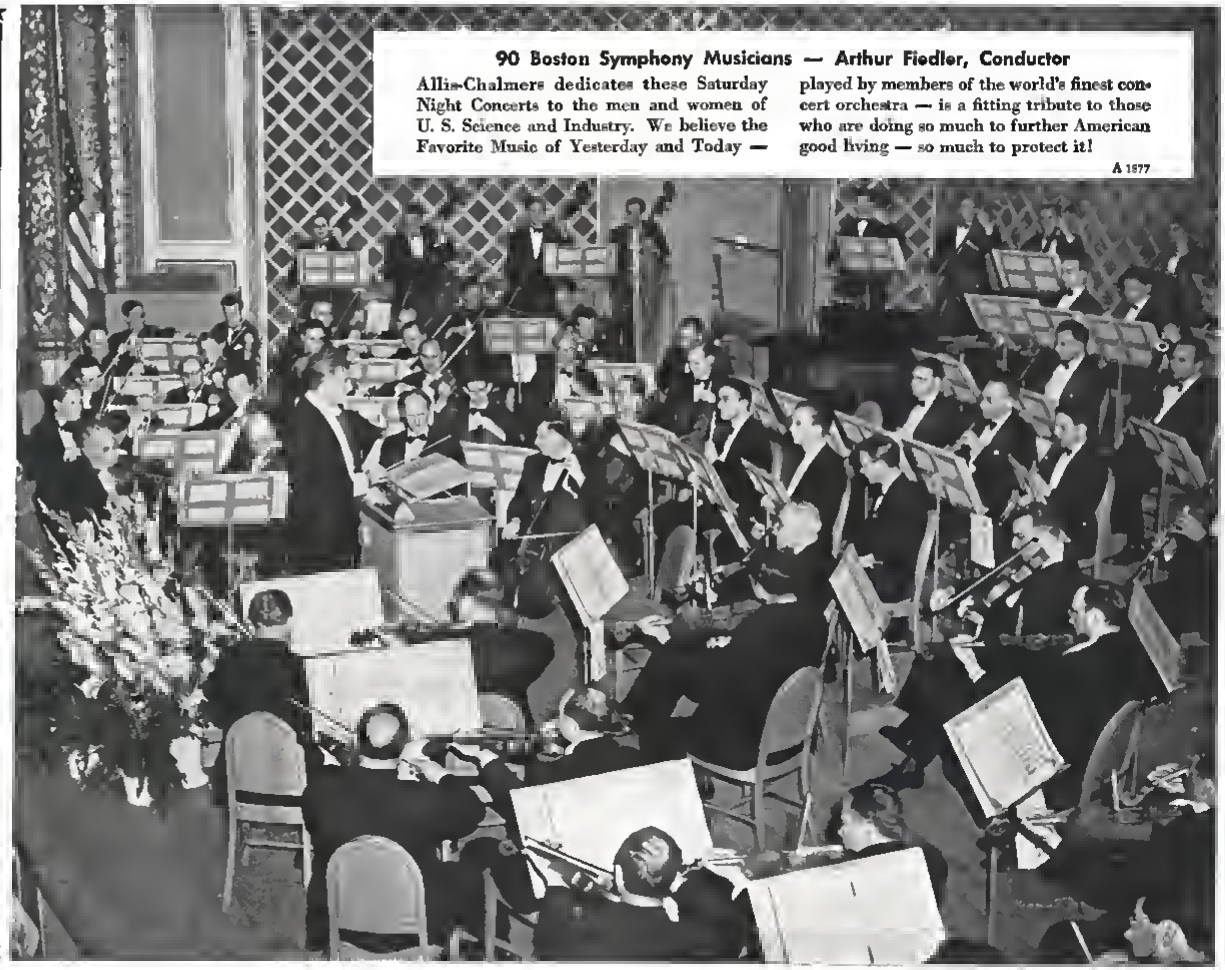

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"Engineering that Aids All Industry—Furthers American Good Living"

PAYROLL SAVINGS PLAN

NOW'S THE TIME FOR *Your* BIG "MOP-UP"!

RE-SOLICITATION is the keynote for a victorious "mop up" in the Mighty 7th War Loan. Bond rallies plus continuous competition between departments help to keep Bond subscriptions on a quota-topping climb. Strategic poster displays . . . showings of "Mr. & Mrs. America," the Treasury film . . . distribution of the War Finance Booklet, "How To Get There," and the handy Bond-holding envelopes play an important part. But, above all else, arrange to have every employee asked *once more*—and personally urged *once more*—to meet his personal quota in the Mighty 7th!

The Payroll Savings Plan is the mainstay of every War Loan—meeting your plant quota is vital to the success of the 7th! Remember we have to make two drives in 1945 do the work of three last year. Put on an intensive "mop up" final to help mop up the Jepe, cut the tentacles of inflation—and lay the foundation of security.

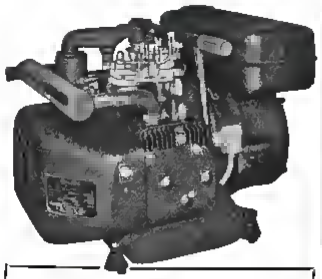
The Treasury Department acknowledges with appreciation the publication of this message by

AVIATION

★ *This is an official U. S. Treasury advertisement prepared under the auspices of Treasury Department and War Advertising Council* ★

ELECTRICITY

TO MEET AVIATION AND AIRCRAFT INDUSTRY POWER NEEDS



ONAN ELECTRIC GENERATING PLANTS provide reliable, economical power for many applications in the aviation industry. Available in 65 models including Airborne, lightweight, compact types. Powered by Onan-built gasoline engines, these electric plants are of compact, single-unit design. Built for heavy duty service, stationary or mobile.

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Successfully used by Pan American Airways—Northwest Airlines—Western Airlines—U. S. Army Air Forces—Air Transport Command—Royal Canadian Air Force.

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ELECTRIC PLANTS
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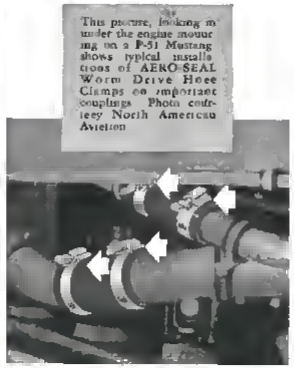
POWER AND LIGHT FOR EVERY NEED

350 to 35,000 WATTS

Models range from 350 to 35,000 watts, A.C. types from 115 to 660 volts; 50, 60, 180 cycles, single or three phase, 400, 500 and 800 cycle, single phase, also special frequencies. D.C. types range from 6 to 4000 volts. Dual voltage types available. Write for engineering assistance or detailed literature.

Supply power for starter energizing . . . radio navigation . . . battery charging . . . communications . . . cabin heating . . . airport and general lighting . . . electrical repair tools . . . aircraft accessories . . . many other applications.

Model shown is from OTC light weight series.



This picture, looking up under the engine mounting on a P-51 Mustang shows typical installations of AERO-SEAL Worm Drive Hose Clamps on important couplings. Photo courtesy North American Aviation.

"Aero-Seal" Clamps prove their value in strenuous service . . .

AIRCRAFT Standard PARTS CO.

AERO-SEAL Worm Drive Hose Clamps were specifically designed to meet strenuous service conditions. The fact that millions of AERO SEALS have done a good job of hose clamping in thousands of Army and Navy aircraft is proof of their outstanding value. High speeds, high pressures and severe vibration characterize the strenuous service under which these clamps must be leak-proof and failure-proof. AERO-SEAL Clamps are distinguished by design features which assure dependable service under these conditions — high-strength steel band, hardened steel worm, one welded interlock joint between band and housing, and narrow saddle. AERO SEAL Clamps made in *all stainless steel* are recommended for aircraft service conditions, where strength performance, and corrosion resistance are important considerations. We originated the AERO-SEAL Worm Drive design and thus can give you the benefit of longest experience in manufacturing this new and better type of hose clamp. *Use AERO-SEAL and be sure of a good and reliable job of clamping.*

"Aero-Seal"

WORM DRIVE **HOSE CLAMPS**

AIRCRAFT STANDARD PARTS CO.
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For better, faster, tighter clamping

Broader Accident Insurance....

for AIR PASSENGERS *at no extra cost*

Passengers in civilian planes on private or non-scheduled commercial flights anywhere in North America can now have protection against all normal aviation hazards as part of regular Connecticut General accident insurance.

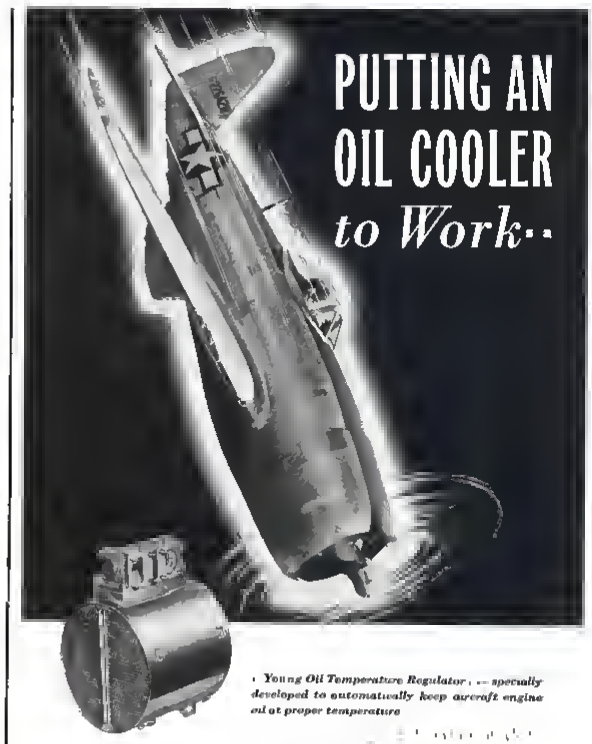
Passengers on commercial airlines can be protected while flying anywhere in the world, including transoceanic flights.

These extensions of coverage, at no extra cost, apply to regular Connecticut General accident policies now in force and being issued.

Thus Connecticut General announces another progressive step consistent with the increased use of air travel. Last November it was first in announcing extension of life insurance protection to cover world-wide flying, and recently it also liberalized accident insurance for airline personnel.

If you use, or plan to use, air travel at all, you should obtain full details about Connecticut General's broadened protection. Any representative will be glad to give you information.

CONNECTICUT GENERAL
LIFE INSURANCE COMPANY
HARTFORD, CONNECTICUT



PUTTING AN OIL COOLER *to Work..*

Young Oil Temperature Regulator — specially developed to automatically keep aircraft engine oil at proper temperature

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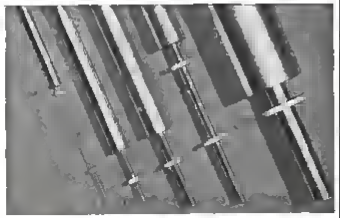
YOUNG RADIATOR CO., DEPT. 295-F, RACINE, WIS., U. S. A.

Concentric Transmission Line

by Doolittle

A Standard Product Since 1934



● Ten years of experience in building concentric transmission line and associated impedance matching equipment assures you highest quality and workmanship.

Doolittle lines are made in seven standard sizes. Each line uses seamless copper tubing for the outer and inner conductor, except Types C-1 and C-6 which use solid inner conductors. The insulating heads are made of low loss ceramic—impervious to moisture—spaced and fastened securely for maintaining proper electrical and mechanical characteristics.

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Special sizes are made to order. For engineering information concerning installation and use, feel free to consult our engineering staff

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ELLIOTT'S

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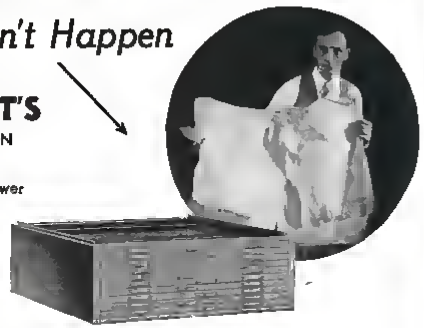
Steel

Shallow Drawer

Unit



Patented tracing lifter in each shallow drawer brings the sheet you want to the top immediately and without creasing, tearing or wrinkling.

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Units are interlocking, non-sagging

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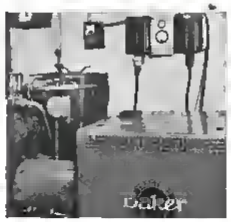
Pittsburgh • Detroit • Cleveland

Photo shows battery charging application of Mines Molded Rubber Connectors



There's a Water-Seal MOLDED RUBBER CONNECTOR Designed For Any Portable Power Supply Application

Many types and sizes of Mines Molded Rubber Connectors have been developed, making them adaptable to almost any application where power is transmitted by portable cable. Stationary receptacles are also available for each portable type.

Molded on the desired cable length for the work to be done, Mines Cable Connectors become a part of the cable itself.

The spring pressure female contacts and the water-seal assure you a safe, positive connection with the male connector for efficient power supply to any machine under all plant conditions.

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Our engineers will gladly work with you in solving portable power transmission problems on capacities up to 5000 volts and 325 amps.

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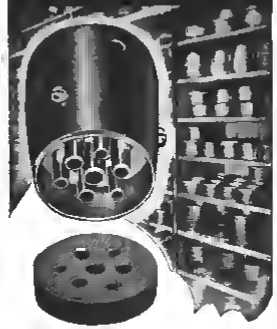

IT IS gratifying to obtain prompt shipment of materials and parts! Even more so, if they exactly suit your purpose. This double achievement is routine occurrence at plants where Booth "prescription" felts — precision die-cut to specifications — are overcoming critical material shortages. Aircraft and other vital war industries thus bypass many a production problem!

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2070

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ECONOMICAL, PRECISION PARTS FABRICATED FROM PLASTICS

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UNITED NATIONS' FLYERS *are using it for* SAFER LANDINGS

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All United Nations' Air Forces for years have used IRVIN as standard equipment . . . and now the Irvin "Single-Release" harness is acknowledged as superior for all landings. IRVIN, as always, leads in Safety.

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Complete Factories in Buffalo, N. Y., Glendale, Calif., (1500 Flower St.), and Lexington, Ky., U. S. A.—Canada, England and Sweden . . . All Serving the United Nation's Air Forces

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Aircraft Washers to government AN specifications:

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4 Holes at One Time!

MULTIPLE drilling of holes from 1/32" up, at a speed as high as 10,000 R.P.M., is no longer an impossibility. It is now being done on many mass production jobs by means of the Govro-Nelson Automatic Drilling Unit, with a set-up such as illustrated above, drilling 4 holes at a time in a brass fuse part.

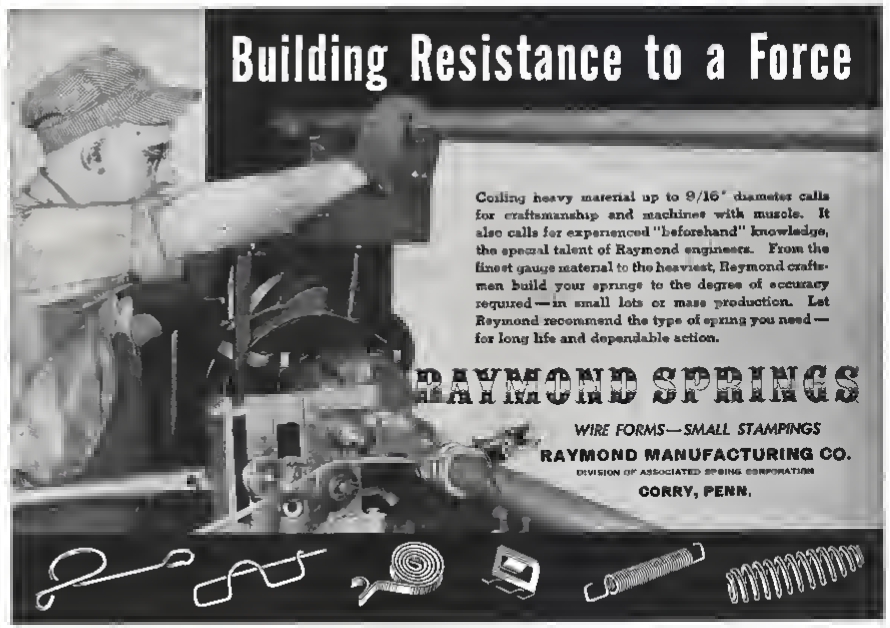
This exceptionally high rate of speed is made possible by the Unit's centrifugal-feed feature, which automatically safeguards the tool against breakage.

Other models available for different speeds and conditions. Designed for drilling up to 3/8" depending upon the material.

WRITE FOR Literature

GOVRO-NELSON CO.
1933 Antoinette
DETROIT 8, MICH.

Automatic **DRILLING UNIT**



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Coiling heavy material up to 9/16" diameter calls for craftsmanship and machines with muscle. It also calls for experienced "beforehand" knowledge, the special talent of Raymond engineers. From the finest gauge material to the heaviest, Raymond craftsmen build your springs to the degree of accuracy required—in small lots or mass production. Let Raymond recommend the type of spring you need—for long life and dependable action.

RAYMOND SPRINGS

WIRE FORMS—SMALL STAMPINGS

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BRANCHES CHICAGO AND LOS ANGELES
CANADIAN FITZGERALD, LTD., TORONTO

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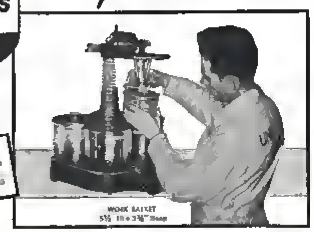
THE COMPLETE LINE THAT COMPLETELY SATISFIES

UNITED AIR LINES

Clean · Rinse · Polish · Dry **INSTRUMENTS..**



Picture taken WHILE on a USAF MAINTENANCE TOUR, CHEYENNE, WYOMING

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Results increase life of mechanisms, reduce need for replacement parts
Method assures uniformity of cleanliness, affords perfect protection for most delicate elements, turns parts out bone dry ready for inspection and use—in less than ten minutes
Machine also used to clean meters, jewels, crystals, radio tube parts, all timing mechanisms and related, highly vulnerable parts
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NEW ADVERTISEMENTS received by June 20th will appear in the July issue within space limitations

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AERONAUTICAL ENGINEERS Need experienced or semi-experienced stress, layout, and weights engineers for important positions in connection with designing of non-wrinkling sandwich aircraft structures. War and post war applications. Write full particulars concerning education, experience and salary requirements to Universal Moulded Products Corporation, Aeronautical Engineering Division, Bristol, Virginia. Attention of Dr. R. J. Noheser

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PRODUCTION CONTROL Engineer and supervisor thoroughly experienced in production problems, accounting and engineering coordination. Will consider permanent position in any organization. Excellent references. PW-917 Aviation, 520 N. Michigan Ave., Chicago 11, Ill.

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SUCCEED POST WAR! Find what you're best fitted for. Free Information. Vocational Testing Clinic, 51-C Lincoln Avenue, Highland Park, N. J.

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A growing Ohio corporation wants a superintendent to take complete charge of production and general factory work.

Ability to handle men and some experience in labor management relations is of primary importance. Age—40 or under. Engineering training desirable.

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P-930, Aviation
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Additional Position Vacant Advertisements on page 408

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A large, comfortable cabin, coupled with twin-engine safety, and the ability to get in and out of small airport gives this airplane general utility value.

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This aircraft is a low-wing monoplane of composite wood, steel and fabric construction and is powered with two Jacobs Model L4MB engines, of 225 horsepower each. These Army models, designated as UC-78 and AT-17 (commercial model T-50), are type-certificated but individual planes must be repaired and modified to meet Civil Aeronautics Administration airworthiness requirements for civilian flight.

Information concerning sales procedure, location of aircraft, and price, may be obtained from your nearest RFC Disposing Agency in the cities listed below.

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Prices for these planes have been set to make allowances toward modifications, repairs and overhaul. The $8500 price is for planes equipped with constant speed propellers, and a wing which is eligible for CAA approval to permit a 5400 pound gross weight. Prices are lower for planes equipped with fixed pitch wood propellers and/or a wing designed for a 5100 pound gross weight.

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(16)

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ADVERTISERS IN THIS ISSUE

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AVIATION'S MARKET PLACE

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Hamstrung by work-spoiling driver skids while he used slotted screws, a certain radio cabinet manufacturer made a complete switch-over to Phillips Recessed Head Screws Result: production shot up like a rocket!

DOWN GO COSTS!

With this upward swing in production, there was a consequent *downward* swing in costs. A downswing that was helped along plenty by the fact that Phillips Screws drive up to 50 percent faster!

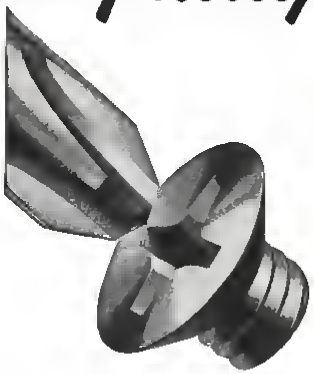
UP GOES STRENGTH!

On production . . . on costs . . . yes, also on design, use of Phillips Screws makes a big difference. Engineered for heaviest driving pressures, they help designers plan exceptional strength and rigidity into products!

AWAY GOES SALES RESISTANCE!

Saleswise, too, use of Phillips Screws pays off. They not only add to a product's strength, smartness, and general good looks. They also banish burrs that snag clothes and sidetrack sales!

It's Phillips — the engineered recess!



In the Phillips Recess, mechanical principles are so correctly applied that every angle, plane, and dimension contributes fully to screw-driving efficiency.

. . . It's the exact pitch of the angles that eliminates driver skids.

. . . It's the engineered design of the 16 planes that makes it easy to apply full turning power – without reaming.

. . . It's the "just-right" depth of recess that enables Phillips Screw Heads to take heaviest driving pressures.

With such precise engineering, is it any wonder that Phillips Screws speed driving as much as 50% – cut costs correspondingly?

To give workers a chance to do their best, give them faster, easier-driving Phillips Recessed Head Screws. Plan Phillips Screws into your product now.

PHILLIPS Recessed Head SCREWS

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Made in all sizes, types and head styles

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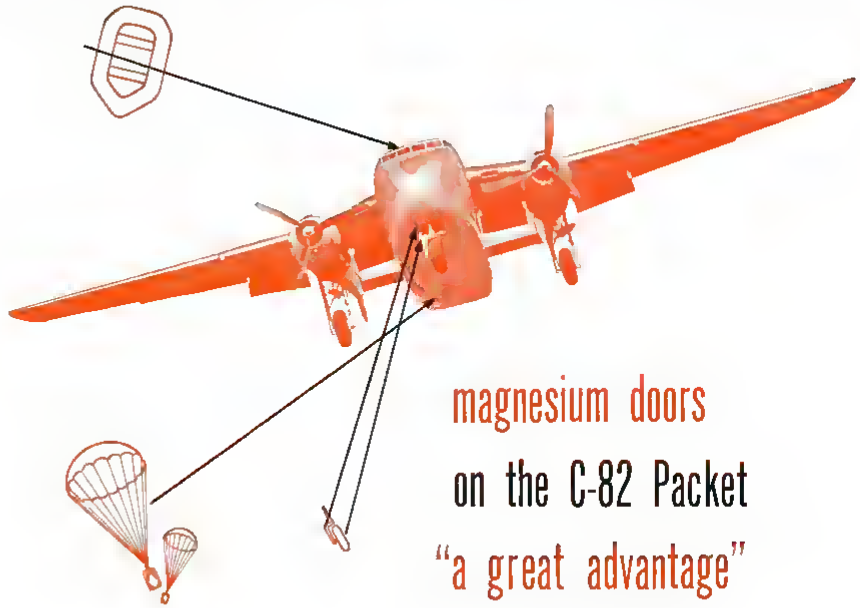
Helping the flying box car bear its mighty burden



magnesium doors on the C-82 Packet "a great advantage"

It would have seemed impossible, just a few years ago—carrying trucks, heavy guns, even light tanks by air. Now it's routine for the huge Fairchild C-82 Packet . . . thanks to the ingenuity of design in the "flying box car."

Magnesium alloys—with the highest strength-weight ratio of all common structural metals—have a very definite place in this accomplishment. To achieve maximum cargo capacity, the Packet carries a minimum of dead weight. That's why several of its doors, for example, are made of magnesium. Included are the paratainer door, through which paratroopers' equipment is parachuted as they jump; the front and side nosewheel doors; and the life raft ejection door, on top of the fuselage.

Fairchild says: "Our use of magnesium in these various parts was determined by the fact that the material is exceptionally light in weight and can be used to great advantage in these places with comparatively little difficulty."

Full engineering data on the use of magnesium in aircraft is available from Dow. Simply get in touch with the nearest Dow office.

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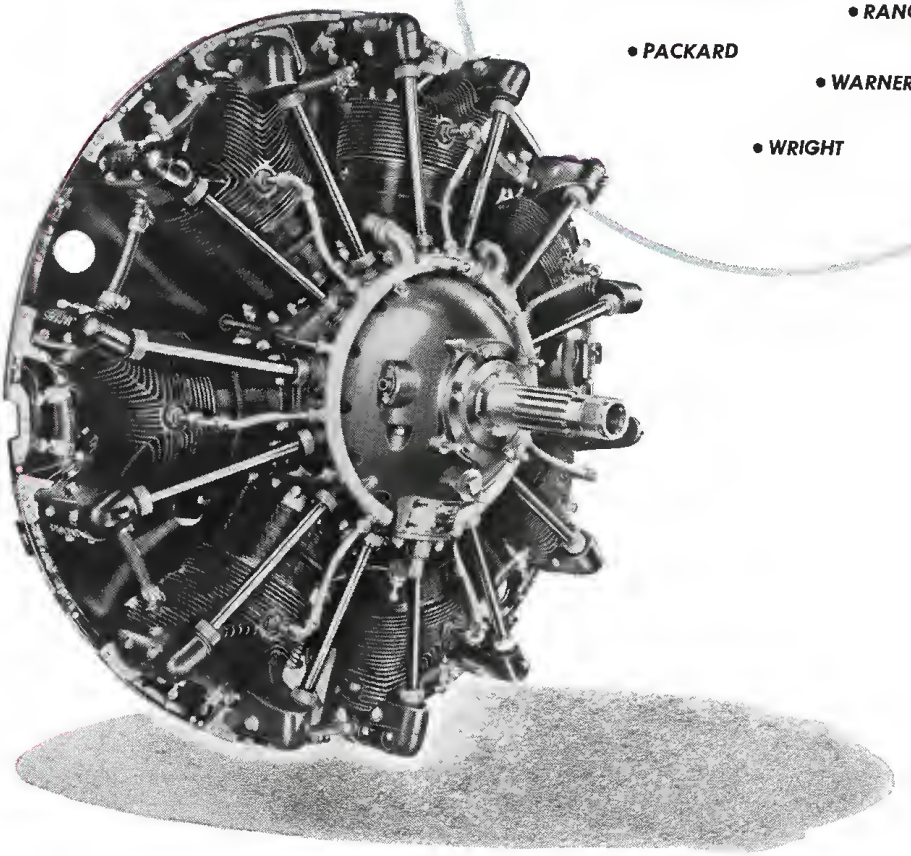

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